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13. ABSTRACT *(Maximum 200 words)*

Objectives: This report provides a comprehensive description of the Airborne School student population and injuries experienced during training, including evaluation of the effectiveness of an outside-the-boot parachute ankle brace (PAB) in preventing injury.

Methods: Databases maintained by the U.S. Army identified first-time Airborne School students, attending October 1998 to December 2006. Inpatient and outpatient records were used to construct site-specific and summary injury measures. Poisson regression models determined the effect of PAB use on selected injury outcomes for men.

Results: Compared to men who didn't use the PAB, those who did had 40% lower risk of ankle injury, with no difference in risks of other injuries. Results persisted with alternate definitions of cohort or risk period. 78% of men finished School in three weeks; 86% finished successfully. Injury during the prior year was more common among men with training interruption(s) and non-graduates. Women had no increases in injuries associated with PAB use.

Conclusions: This study demonstrated reduced risk of ankle injury when the PAB was used, with no increase in the risk of other injuries. Our findings persisted, regardless of variations in subgrouping or definition of risk period. The small number of women trainees limited that subgroup analysis.

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Technical Report: Parachute Ankle Brace Effectiveness Evaluation

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May 2010

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The opinions or assertions contained herein are the private views of the author(s) and are not to be construed as official or reflecting the views of the Army or the Department of Defense.

The investigators have adhered to the policies for protection of human subjects as prescribed in Army Regulation 70-25, and the research was conducted in adherence with the provisions of 32 CFR Part 219.

Investigators adhered to AR 70-25 and USAMRMC Regulation 70-25 on the use of volunteers in research. The protocol for this study was reviewed and approved by the Institutional Review Boards of ENVIRON International Corporation, the Army Research Institute of Environmental Medicine, and the Army Medical Research and Materiel Command.

Any citations of commercial organizations and trade names in this report do not constitute an official Department of the Army endorsement of approval of the products or services of these organizations.

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Funding for this work was provided by the US Department of the Army, contract number W911QY-09-P-0316.

EXECUTIVE SUMMARY

Objectives: This report provides a comprehensive description of the Airborne School student population and injuries experienced during training. Specific objectives of the report include: 1) evauating the effectiveness of an outside-the-boot parachute ankle brace (PAB) in preventing both severe and less severe injury among men; 2) assessing the sensitivity of the effectiveness evaluation to a change in the definition of the risk period on the association between PAB use and ankle injury; 3) describing injuries experienced among graduates and non-graduates, and among students who experienced interruption(s) (e.g., Turnback) during training; and 4) describing injuries experienced by women trainees.

Methods: Existing databases maintained by the U.S. Army were used for all analyses. All active duty, Regular U.S. Army personnel who first attended the Airborne School between October 1, 1998 and early December 2006 were eligible for inclusion in the study. Four analysis cohorts, corresponding to the four study objectives, were drawn from this eligible group. Both hospital records and ambulatory care records were acquired and used to construct multiple, site-specific and summary outcome measures based on International Classification of Diseases 9th Revision, Clinical Modification (ICD-9-CM) codes. For the cohort that progressed to the third week of training ("jump week"), we developed several Poisson regression models to analyze the effect of PAB use on selected injury outcomes, including ankle injury. For the larger cohort of all trainees who entered Airborne School, we conducted descriptive analyses to characterize graduates and non-graduates.

Results: Among men advancing to the third week of Airborne School, those undergoing training during the two periods when PAB use was mandated had 40% lower risks of ankle injury (Brace I RR= 0.60, 95% CI 0.47, 0.75 and Brace II RR= 0.62, 95% CI 0.49, 0.78), with no difference in risks of other types of injuries, compared to periods when the PAB was not used. The sensitivity analysis confirms that changing the definition of the risk period based on first vs. last jump week for those with interruptions in training did not alter the association between ankle injury and brace use: Point estimates and confidence intervals were essentially unchanged, and a strong protective effect persisted for the Brace I and II periods compared to periods of no brace use. 78%, of students who started Airborne School completed the program in the scheduled three weeks, and most of those who started the program, 86%, completed it successfully. Injury during the year prior to entry into the Airborne School was more common among students whose training was delayed or who did not complete Airborne School than those who completed the program. Descriptive analyses of women trainees demonstrated no increases in injuries associated with use of the PAB.

Conclusions: This study corroborates previous investigations that identified reduced risk of ankle injury when the PAB was used during Airborne training (7, 10) with no accompanying increase in the risk of other injuries (2, 7, 11). There were no differences in risk of ankle injury comparing periods when brace use was not mandated.

The findings reported here were consistent when analyses were focused on men who entered training, men who finished training, and when training was defined on the basis of first or last recorded jump week. It was not possible to carry out as complete an analysis for women, due to the small numbers of women who entered the Airborne School during the study period.

Among men entering Airborne School, our analysis indicates that students who were turned back during training, i.e., experienced interruptions, were likely to return to the program and successfully complete it, demonstrating appropriate selection into the program and adequate rehabilitation or remedial training for those who needed it. Additionally, prior injury history may prove a useful indicator to identify students in need of different training or more careful surveillance during Airborne School to assure success in the program.

INTRODUCTION

Ankle injuries among military parachutists account for 30 to 60% of all parachuting-related injuries, with estimated incidence ranging from 1 to 4.5 per 1,000 jumps (4-7, 9, 11). These injuries result in substantial direct and indirect medical costs and have a negative impact on mission readiness. To reduce the risk of ankle injuries, an outside-the-boot parachute ankle brace (PAB) was developed and has been used by the US Army, primarily during training. The PAB, developed by Aircast® Corporation (purchased by DjOrtho® in 2006) consists of a hard plastic outer shell lined with air bladders which pad the medial and lateral malleoli, preventing extreme ankle inversion and eversion while allowing plantarflexion and dorsiflexion (8, 10). Each ankle brace costs $28.50 (8).

An initial, limited evaluation of PAB effectiveness, conducted at the US Army Airborne School (Fort Benning, GA) in October 1993 (2), showed that the PAB reduced by 85% the incidence of ankle sprains among 745 trainees evaluated, which led in 1994 to requirements for all trainees at the school to use the PAB. PAB use was discontinued in October 2000 due to financial concerns and anecdotal reports of an increase in certain other injuries potentially related to PAB use (7). A study of all Army Airborne trainees (10), however, found that use of the PAB appeared to reduce the risk of severe ankle injuries without increasing the risk of other types of traumatic injury, and that medical costs avoided far exceeded the cost of acquiring the braces. These results contributed to the decision to reintroduce the PAB in July 2005; they were used until late 2006, then use was again discontinued.

Although a subsequent study by Knapik et al (7) corroborated previous observations that PAB wearers were at reduced risk of ankle injury, without a concomitant increase in other lower body injuries, the study was limited in scope. Thus, the current study extends the Schmidt et al (10) investigation, including all Army Airborne trainees who initiated Jump School on or after October 1, 1998 and including 8.5 months of brace use after their reintroduction in 2005.

OBJECTIVES

This report provides a comprehensive description of the Airborne School student population and injuries experienced during training. Four analysis cohorts corresponding to project objectives are described below (see Cohort Enumeration). Specific objectives of the report include:

1. Effectiveness evaluation among men:
   a. Assess the effectiveness of the PAB in preventing injury;
   b. Determine if previous observations that the brace protects against severe ankle injury can be replicated;
   c. Investigate possible differences in the value of the ankle brace as a protective device against less severe injuries than previously considered;

2. Sensitivity analyses to evaluate the effect of a change in the definition of the risk period on the association between PAB use and ankle injury.

3. Description of injuries experienced among graduates and non-graduates, and among students who experienced interruption(s) (e.g., Turnback) during training.

4. Description of injuries experienced by women trainees, who comprised 3% of eligible trainees. The small number of women trainees precluded detailed analysis of injury risks.

METHODS

DATA SOURCES

Existing databases were used for all analyses. Electronic student rosters have been maintained by the Airborne School since 1995. Trainees were identified from electronic student rosters, which contained data regarding training start date, training class/company, graduation status, and reason for not graduating (if applicable). The roster database also provided disposition status for trainees who experienced interruption(s) in training. Interruptions were classified as Turnback, temporary disqualification, permanent disqualification, or hold; the latter three categories indicate non-graduates. A "Turnback" represents one type of interruption for any of a variety of reasons, including injury that ended in a return to the program and graduation, usually within six months.

Outcome and covariate data were drawn from the Total Army Injury and Health Outcomes Database (TAIHOD), which includes biannual personnel files from the Defense Manpower Data Center (DMDC) database and hospital records from the Individual Patient Data System (IPDS). Ambulatory care records for military facilities are maintained in the Standard Ambulatory Data Record (SADR), and for non-military facilities in the Health Care Service Record (HCSR) and Tricare Encounter Data – Institutional (TED NI). The TAIHOD has been described elsewhere (Amoroso 1999).

Data from inpatient sources became available for inclusion in the TAIHOD in 1980, while outpatient sources were not available until October 1, 1997; both sources were complete through September 2007. Students were linked via an encrypted identification number to the earliest DMDC record available within one year of the start of Airborne training. Active duty status was verified using date of entry into military service and branch of service codes.

DMDC data provided sex, race/ethnicity, age, and rank. Age and duration of Army service were categorized into approximate quintiles based on the distribution of the entire cohort. Race/ethnicity categories were white, black, Hispanic, and other.

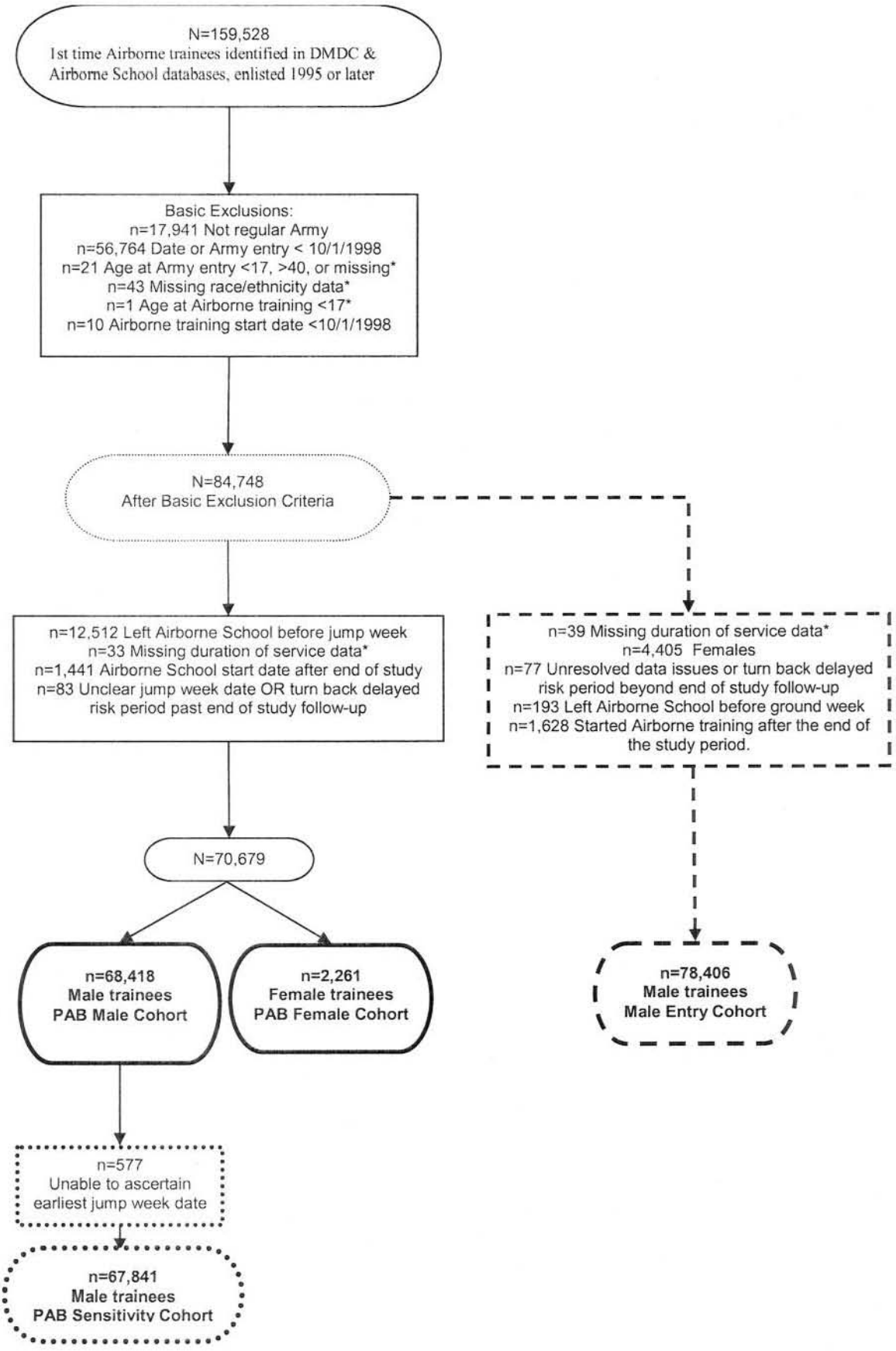
Rank was based on paygrade and summarized into two categories, enlisted (E1 to E9) and commissioned and Warrant officers.

COHORT ENUMERATION

The Airborne School is a 3-week program, consisting of two weeks of land-based training followed by five static-line parachute jumps during the final week (i.e., "jump week"). Based on availability of outcome data, all active duty, Regular U.S. Army personnel who first attended the Airborne School between October 1, 1998 and early December 2006 were eligible for inclusion in the study. This allowed assessment of injuries during the year prior to attending Airborne School and follow-up for two full weeks (see definition of risk period, below) for the last Airborne class of 2006, which began November 27, 2006.

A preliminary group of 159,528 students was identified from Airborne and DMDC data files as first time trainees entering the Army in 1995 or later. Four analysis cohorts were drawn from this preliminary group: male cohort, sensitivity analysis cohort, female cohort, and male entry cohort. Each cohort will be described below. Basic exclusion criteria applied to all four cohorts included: not Regular Army; Army entry date before October 1, 1998; less than 17 or more that 40 years of age upon entry in the Army; missing demographic data; less than 17 years of age at start of Airborne School; started Airborne School before October 1, 1998 or after November 27, 2006. The exclusions based on age and missing data were thought to represent coding errors. (Figure 2.1)

Figure 2.1 PAB Extension Project: Eligibility and exclusion criteria for four analysis cohorts



* Represent likely coding errors

BRACE PROTOCOL PERIOD CLASSIFICATION

Assignment to a brace use category for each trainee was based on the date each began jump week. For most trainees this was 14 days after the start of the program; for others the first day of jump week was ascertained by examination of class and Turnback data in their records. See additional information below, specific to each analysis objective and cohort.

Individual use or non-use of PAB was not recorded, but Army procedures specified assignment to PAB use based on class/company and time period. Trainees were assigned to companies A, B, C, or D at the beginning of the three week program; company was assigned on a rotating basis as each new group of students started the program. Trainees who were turned back during the program were reassigned to the current active company upon return To training. Compliance is expected to be nearly 100% for those assigned to use the PAB. Table 2.1 summarizes brace use periods. The PAB was used by all classes/companies starting jump week between October 1, 1998 and September 30, 2000 ("Brace I") and was not used between October 1, 2000 and July 4, 2005 ("No Brace I"). "Brace II" and "No Brace II" were concurrent, July 5, 2006 to December 11, 2006. During this time period, A and B Companies used PAB while C and D Companies did not (personal communication, F. Manning 10/1/2007).The "Brace I" and "No Brace I" periods overlap with the original study brace protocol periods (10). .

Table 2.1 Parachute Ankle Brace Protocol Periods,* 1998 - 2006

Dates	Protocol
10/01/1998 to 9/30/2000	Brace I
10/01/2000 to 07/04/2005	No Brace I
07/05/2005 to 12/11/2006	Brace II - Companies A & B
07/05/2005 to 12/11/2006	No Brace II – Companies C & D

* Dates based on 1st day of "jump week."

OUTCOMES

Records were obtained for all hospital admissions between October 1, 1997 and December 31, 2006. Each record included admission and discharge dates, and up to eight diagnoses and procedures coded according to International Classification of Diseases 9th Revision, Clinical Modification (ICD-9-CM). Ambulatory records were obtained for all outpatient episodes of care for the same time period. Outpatient data from nonmilitary medical facilities (found in HCSR, TED/NI databases), as well as that

from the usual military facilities (found in the SADR databases), were included to provide a more comprehensive assessment of ambulatory care. Outpatient records included date of care, up to eight ICD-9-CM diagnosis codes and up to four procedures coded according to the Current Procedural Terminology (CPT) system.

The Barell injury diagnosis matrix was used to classify ICD-9-CM diagnoses for traumatic injuries into 20 body regions (3). Outcome definitions for these indicator variables derived from outpatient ICD-9-CM codes were modified to also incorporate relevant ICD-9-CM codes not typically used in the inpatient setting (V-codes, and codes in the 700s or 900s). Definitions for the 20 Barell indicators are mutually exclusive, and shown in Appendix A.

We also constructed several summary outcome indicators that better represented the primary focus of the study. The main outcome of interest was ankle injury, which includes ICD-9-CM codes also found in the Barell indicators for lower leg injury and other lower extremity injury. The complement to the ankle injury indicator, representing non-ankle injury, was constructed. It comprised all traumatic injury codes excluding those for ankle injury, and also including codes for musculoskeletal injury and soft-tissue injury. A lower extremity (non-ankle) injury indicator was constructed that combines the non-ankle ICD-9-CM codes found in both Barell indicators for lower leg injury and other lower extremity injury. Finally, summary indicators for musculoskeletal injury and multiple injuries were constructed; the latter indicating traumatic injury to more than one distinct body region based on the 20 Barell indicators. Non-ankle injury and musculoskeletal injury indicators include ICD-9-CM codes also found in the Barell indicators for knee, hip, and vertebral column injuries, as well as codes found in the summary lower extremity (non-ankle) injury indicator (Appendix A).

Outcome indicators for medical procedures of the ankle were defined using ICD-9-CM diagnosis codes from inpatient data and CPT codes from outpatient sources. We also constructed indicator variables representing ankle injury and any non-ankle injury recorded during the one year period immediately preceding jump week (Appendix A).

Three injury outcomes were identified as being of primary importance: ankle injuries, non-ankle injuries, and vertebral column injuries (one of the 20 Barell injury matrix body regions). A small, non-statistically significant increase in risk of vertebral column injuries was previously reported to be associated with use of PAB (10). Supplementary analyses focus on the constructed summary indicators for musculoskeletal and lower extremity injuries, and Barell indicator for knee injury.

EPISODES OF CARE

There were multiple, nearly matching records in the outpatient data files. Records matching on date of care were considered to represent the same episode of care. A count variable was created to represent the number of unique episodes of outpatient care for each trainee. Nearly all trainees hospitalized during the specified risk period

also received ambulatory care during the risk period. We combined all records for each trainee, retaining all outcome indicator information and the earliest date of care for both inpatient and outpatient episodes. Outcome indicators found in the final medical record for each trainee represent the presence or absence of a particular type of injury during the specified risk period.

SEVERITY OF INJURY

Both inpatient and outpatient data were used to define severity of injury variables for selected outcomes, specifically, ankle, knee, lower extremity (non-ankle), vertebral column, and musculoskeletal injuries. Increasing levels of severity were defined as follows:

- no injury to specified body part;
- one outpatient visit, but no hospitalization;
- one or more outpatient visits, but no hospitalization;
- one or more outpatient visits and hospitalization;
- hospitalization only.

Because of the very small number of the most severe events, the severity indicators were combined into:

- no injury to specified body part;
- one outpatient visit, but no hospitalization;
- one or more outpatient visits, but no hospitalization
- multiple outpatient visits and/or hospitalization.

STATISTICAL METHODS

SAS version 9.1 was used for data management and analysis (2002-2003 by SAS Institute Inc., Cary, NC, USA). Descriptive characteristics for airborne trainees were calculated for each brace protocol period. Injury rates were calculated for each protocol period by dividing the number of injuries by the total number of trainees during the protocol period. Rate ratios and 95% confidence intervals (95% CI) were used to quantify the relative risk of injury during the second "no brace" period and the two brace periods compared to the first "no brace" period.

Poisson regression was used to determine the association between selected outcomes and brace protocol period, controlling for selected covariates. The following covariates were considered in the modeling process for all outcomes: age at start of training, race/ ethnicity, rank, duration of service, ankle injury during the previous year, non-ankle injury during the previous year and Turnback during training. Covariates associated with an injury outcome at p-value ≤ 0.20 were entered into a preliminary multivariable model. Those with the highest p-values were removed individually until all variables in the model were associated with the injury outcome at $p \leq 0.05$. An interaction variable representing Turnback status and any type of injury during the previous year was constructed and considered for inclusion in models. Potential

confounding by covariates that were not statistically significantly associated with injury was assessed by examination of the change in rate ratio for any other variable in the model. ROC (Receiver Operating Characteristic) curves were plotted for each model to assess discrimination level.

OBJECTIVE 1: EFFECTIVENESS EVALUATION AMONG MEN

METHODS

Cohort Enumeration

The male cohort consisted of men who advanced to jump week, the third and final week of training, regardless of whether they actually finished the training program. Therefore, trainees who left Airborne School before the start of jump week were additionally excluded from this cohort. Graduation status was not considered in selecting the analysis cohort because data specifying the timing of withdrawal from training were incomplete, and injury often results in non-graduation. Had non-graduates been excluded, a biased sample of students would have resulted.

Ninety percent of trainees had no interruption in training (61,879/68,418), and started jump week 14 days after the start of the program. For others, the first day of jump week was ascertained by examination of class and Turnback data. Because the roster data files represented the most recent status for each trainee (i.e., earlier data entries were overwritten), we were able to ascertain the *latest* jump week date for almost all trainees who were turned back during Airborne training. Thus, this analysis was based on the latest jump week. A small number of trainees (n=83) were dropped from analysis because data were inadequate to determine the jump week date or because interruptions in training delayed risk periods (defined below) until after the end of the study. The final analysis cohort comprised 68,418 male trainees.

Brace Protocol Period Classification

Brace use or non-use was universal for all classes through June 2005, and determined solely by the date of the latest jump week on record. The PAB was employed on a two-week rotating schedule between July 2005 and December 2006, so brace use category for this time period was determined by the class and company assignment corresponding to the date for the latest jump week attended (see Table 2.1).

Risk Period

Results from Schmidt et al. (10) indicated that some students may delay treatment until after completion of Airborne training, but that most seek care during the week immediately following the program. Since injury may lead to a termination of training, there is strong incentive to postpone care, if possible. Therefore, the risk period was defined as a two week period beginning with the first day of the latest jump week, and all injuries recorded during the two week risk period were considered parachute-related.

RESULTS

Descriptive Statistics

Overall, 12.9% (n=8,805) of trainees entered jump week during the Brace I period, 65.5% (n=44,828) during the No brace I period, 10.4% (n=7,139) during the Brace II period, and 11.2% (n=7,646) during the No brace II period. Trainees attending during the more recent brace periods (Brace II and No brace II) tended to be older with longer duration of service, and were more frequently turned back during training (Table 3.1). There were 325 hospitalizations and 7,905 outpatient care visits during the two week risk period (both for injuries and non-injury-related care). All but one of the hospitalized trainees also had at least one outpatient visit. Ankle injuries comprised 29% (1036/3550) of all injury-related episodes of care, and 35% (361/1036) of ankle injuries were fractures (data not shown).

Table 3.1. Descriptive Characteristics of U.S. Army Airborne School Male Trainees* by Parachute Ankle Brace (PAB) Protocol, 1998-2006 (n=68,418)

	PAB Protocol							
	Brace I (N = 8,805)		No brace I (N = 44,828)		Brace II Co A & B (N = 7,139)		No brace II Co C & D (N = 7,646)	
	N	%	N	%	N	%	N	%
Age at start of training (yrs), quintiles								
17-18	1,829	20.8	8,864	19.8	1,225	17.2	1,224	16.0
19	2,293	26.0	10,050	22.4	1,324	18.6	1,393	18.2
20-21	2,177	24.7	10,101	22.5	1,589	22.3	1,773	23.2
22-23	1,372	15.6	7,119	15.9	1,197	16.8	1,392	18.2
24-44	1,134	12.9	8,694	19.4	1,804	25.3	1,864	24.4
Race/ethnicity								
White	6,329	71.9	33,453	74.6	5,513	77.2	5,818	76.1
Black	933	10.6	3,952	8.8	496	7.0	581	7.6
Hispanic	1,038	11.8	5,177	11.6	783	11.0	832	10.9
Other	505	5.7	2,246	5.0	347	4.9	415	5.4
Rank								
Enlisted (E-1 to E-9)	8,194	93.1	41,783	93.2	6,496	91.0	6,945	90.8
Officer/Warrant Officer	611	6.9	3,045	6.8	643	9.0	701	9.2
Duration of service (yrs), quintiles								
0 to 16 weeks	1,813	20.6	9,378	20.9	1,357	19.0	1,687	22.1
17 to 19 weeks	1,839	20.9	8,351	18.6	1,873	26.2	1,741	22.8
20 to 24 weeks	2,346	26.6	9,532	21.3	1,048	14.7	1,098	14.4
25 to 36 weeks	2,041	23.2	8,712	19.4	1,126	15.8	1,139	14.9
37 weeks to 8 yrs	766	8.7	8,855	19.8	1,735	24.3	1,981	25.9
Turn back & previous injury past year								
No TB or previous injury	4451	50.6	23,182	51.7	3,710	52.0	4,045	52.9
Previous injury only	3481	39.5	17,785	39.7	2,542	35.6	2,683	35.1
TB only	347	3.9	1,550	3.5	369	5.2	404	5.3
Both TB and previous injury	526	6.0	2,311	5.2	518	7.3	514	6.7
Failed to graduate	67	0.8	605	1.4	60	0.8	86	1.1

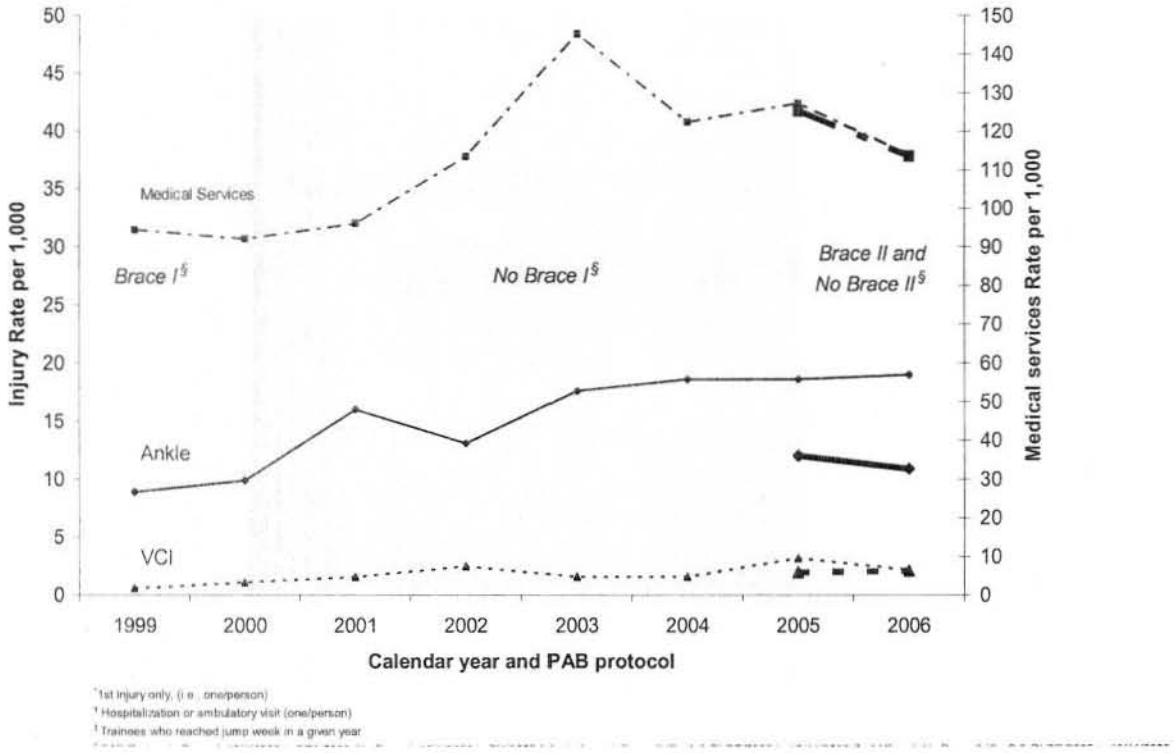
* First time attendees starting airborne training 10/1/1998 -11/27/2006

† Last recorded jump week training dates corresponding to PAB Protocol were as follows: Brace I 10/1/1998 to 9/30/2000, No brace I 10/1/2000 to 7/4/2005, Brace II (Co A & B) 7/5/2005 to 12/11/2006, No brace II (Co C & D) 7/5/2005 to 12/11/2006

Selected Outcomes by Year of Training

Figure 3.1 shows unadjusted rates of ankle injury, vertebral column injury, and medical service use by year of training. Generally, ankle injuries were more common during the periods when the ankle brace was not used. VCI occurred very rarely (range 0.6 to 3.2 per 1,000 each year), with no apparent association with brace use. Use of medical services showed considerable variation by calendar year, with higher rates during later years, but no consistent association with brace use.

Figure 3.1. Ankle injury,* vertebral column injury (VCI),* and use of medical services†: Rates/1,000 male trainees‡ during 2 week risk period, by year of training and PAB protocol,§ n=68,418



*1st injury only, (i.e., one/person).
† Hospitalization or ambulatory visit (one/person).
‡ Trainees who reached jump week in a given year.
§ PAB Protocol : Brace I 10/1/1998 to 9/30/2000, No Brace I 10/1/2000 to 7/4/2005 (shaded area), Brace II (Co A & B) 7/5/2005 to 12/11/2006 (bold lines), No Brace II (Co C & D) 7/5/2005 to 12/11/2006.

Selected Outcomes Stratified by PAB Protocol

Table 3.2 presents injury outcomes stratified by PAB protocol period.

- Ankle injuries were more likely during the periods when the PAB was not in use (1.66% and 1.71% for No Brace I and No Brace II, respectively) compared to periods when the PAB was used (0.93% and 1.12%, for Brace I and Brace II, respectively).
- Ankle fractures were more common when the PAB was not used (0.60% and 0.60% for No Brace I and No Brace II, respectively) compared to periods when the PAB was used (0.22% and 0.41%, for Brace I and Brace II, respectively).
- The rates of lower extremity (non-ankle) injury, knee injury, VCI, multiple injuries, musculoskeletal injury, and any non-ankle injury were lowest during Brace I, but similar across other PAB use and non-use periods.
- Among 2,471 trainees with a non-ankle injury, the most common injuries were musculoskeletal (n=577/68,418, 0.8%), lower leg (n=402/68,418, 0.6%), other lower extremity (n=343/68,418, 0.5%), and back (n=240/68,418, 0.4%, data not shown).
- The rates of the summary category "any type of injury", were similar during the two periods of brace use. They were slightly higher during for the two periods of no brace use.
- Traumatic brain injury was somewhat more common during the periods of no PAB use (0.23% and 0.20% for No Brace I and II, respectively) compared to brace use periods (0.09% and 0.13% for Brace I and Brace II), though the overall frequency of traumatic brain injury was very low (0.2%)
- The frequency of lower leg injury, based on the Barell indicator which includes some ankle injury codes, was higher during each of the no brace use periods.
- None of the remaining Barell injury categories (other head, face, neck; spinal cord, chest, abdomen, pelvis, trunk, back, shoulder, forearm, wrist, other upper extremity, upper leg, foot, other lower extremity, other/multiple sites) were associated with brace use period.

Table 3.2. Selected Injury Outcomes for U.S. Army Airborne School Male Trainees* Based on Inpatient & Outpatient Data, by Parachute Ankle Brace (PAB) Protocol, 1998-2006, PAB Extension Cohort (n=68,418)

	PAB Protocol								
	Brace I† (N = 8805)		No brace I† (N = 44,828)		Brace II† Co A & B (N = 7,139)		No brace II† Co C & D (N = 7,646)		Overall Chi-Square
Outcome	N	%	N	%	N	%	N	%	p-value
Ankle injury ‡	82	0.93	743	1.66	80	1.12	131	1.71	<0.0001
Ankle fracture §	19	0.22	267	0.60	29	0.41	46	0.6	<0.0001
Ankle and/or lower leg procedure ‡ **	8	0.09	375	0.84	47	0.66	61	0.8	<0.0001
Lower extremity (non-ankle) injury ‡	63	0.72	488	1.09	79	1.11	71	0.93	0.01
Knee injury ‡	8	0.09	118	0.26	12	0.17	14	0.18	0.008
Any hip injury ‡	11	0.12	92	0.21	18	0.25	12	0.16	0.24
Any vertebral column injury ‡	7	0.08	90	0.20	15	0.21	18	0.24	0.07
Injury to multiple body parts ‡ ††	59	0.67	500	1.12	65	0.91	81	1.06	0.002
Musculoskeletal injury ‡ ‡‡	73	0.83	571	1.27	80	1.12	83	1.09	0.004
Any traumatic (non-ankle) injury ‡ ‡‡	244	2.77	1,687	3.76	272	3.81	268	3.51	<0.0001
Any type of injury ‡ §§	349	3.96	2,453	5.47	355	4.97	393	5.14	<0.0001
Non-injury hospitalization/ outpatient visit§§	549	6.24	3,261	7.27	551	7.72	529	6.92	0.001
Traumatic brain injury	8	0.09	103	0.23	9	0.13	15	0.20	0.03
Other head, face, neck	17	0.19	163	0.36	24	0.34	21	0.27	0.06
Spinal cord	1	0.01	1	<.01	1	0.01	1	0.01	0.40
Chest (thorax)	5	0.06	51	0.11	7	0.10	2	0.03	0.08
Abdomen	1	0.01	5	0.01	7	0.10	0		<0.0001
Pelvis	17	0.19	83	0.19	13	0.18	7	0.09	0.32
Trunk	4	0.05	39	0.09	3	0.04	1	0.01	0.07
Back	36	0.41	163	0.36	25	0.35	29	0.38	0.92
Shoulder	19	0.22	136	0.30	30	0.42	25	0.33	0.14
Forearm	5	0.06	37	0.08	6	0.08	11	0.14	0.27
Wrist	12	0.14	60	0.13	13	0.18	11	0.14	0.79
Other upper extremity	4	0.05	31	0.07	9	0.13	7	0.09	0.26
Upper leg	9	0.10	31	0.07	8	0.11	8	0.10	0.46
Lower leg	95	1.08	941	2.10	117	1.64	142	1.86	<0.0001
Foot	27	0.31	234	0.52	25	0.35	28	0.37	0.009
Other lower extremity	67	0.76	425	0.95	65	0.91	83	1.09	0.18
Other/multiple sites	24	0.27	106	0.24	22	0.31	23	0.30	0.55

* First time attendees starting airborne training 10/1/1998 -12/1/2006.

† Last recorded jump week training dates corresponding to PAB Protocol were as follows: Brace I 10/1/1998 to 9/30/2000, No brace I 10/1/2000 to 7/4/2005, Brace II (Co A & B) 7/5/2005 to 12/11/2006, No brace II (Co C & D) 7/5/2005 to 12/11/2006.

‡ Hospitalization or outpatient appointment occurring during a 14 day period from the start of latest jump week through the week following airborne training.

§ Ankle fracture outcome is subset of ankle injury outcome.

¨ Any ankle procedure is based on CPT codes (not ICD-9 codes) and overlaps with ankle injury.

†† Injury to multiple body parts overlaps with all other outcomes.

‡‡ Musculoskeletal injury and any traumatic non-ankle injury outcomes include ICD codes also found in knee, hip, vetebral column, and lower extremity injuries, but not ankle. Any traumatic (non-ankle) injury includes both musculoskeletal (non-ankle) injury and soft-tissue injuries.

§§ A trainee could have both injury and non-injury hospitalization and/or outpatient visit(s).

Table 3.3 presents severity of injury outcomes stratified by PAB protocol period.

- The most severe ankle injury category had similar rates during Brace II (0.28%) and both no brace periods (0.30% for No Brace I and 0.34% for No Brace II). The most severe ankle injuries occurred much less frequently (0.07%) during Brace I ($p>0.0001$).
- Musculoskeletal injury and lower extremity injury severity were not associated with brace use.
- No patterns of severity by brace use were seen for vertebral column injury or knee injury, though there were very few severe cases of either.

Table 3.3. Selected Severity of Injury Outcomes for U.S. Army Airborne School Male Trainees* Based on Inpatient & Outpatient Data, by Parachute Ankle Brace (PAB) Protocol, 1998-2006, PAB Extension Cohort (n=68,418)

	PAB Protocol							
	Brace I† (N = 8805)		No brace I† (N = 44,828)		Brace II† Co A & B (N = 7,139)		No brace II† Co C & D (N = 7,646)	
Severity Outcome‡	N	%	N	%	N	%	N	%
Ankle injury severity§ :								
No injury	8,723	99.07	44,085	98.34	7,059	98.88	7,515	98.29
1 outpatient visit	57	0.65	395	0.88	46	0.64	72	0.94
>1 outpatient visit, no hospitalization	19	0.22	215	0.48	14	0.20	33	0.43
≥1 outpatient visit and/or hospitalization (with or without ankle procedure)	6	0.07	133	0.30	20	0.28	26	0.34
Vertebral column injury severity :								
No injury	8,798	99.92	44,738	99.80	7,124	99.79	7,628	99.76
1 outpatient visit	6	0.07	66	0.15	10	0.14	13	0.17
>1 outpatient visit, no hospitalization	0	0.00	10	0.02	2	0.03	5	0.07
≥1 outpatient visit and/or hospitalization	1	0.01	14	0.03	3	0.04	0	0.00
Musculoskeletal injury severity :								
No injury	8,732	99.17	44,257	98.73	7,059	98.88	7,563	98.91
1 outpatient visit	55	0.62	437	0.97	54	0.76	66	0.86
>1 outpatient visit, no hospitalization	11	0.12	91	0.20	18	0.25	10	0.13
≥1 outpatient visit and/or hospitalization	7	0.08	43	0.10	8	0.11	7	0.09
Lower extremity injury severity :								
No injury	8,743	99.30	44,350	98.93	7,060	98.89	7,576	99.08
1 outpatient visit	55	0.62	415	0.93	62	0.87	6	0.78
>1 outpatient visit, no hospitalization	6	0.07	55	0.12	15	0.21	8	0.10
≥1 outpatient visit and/or hospitalization	1	0.01	8	0.02	2	0.03	2	0.03
Knee injury severity								
No injury	8,797	99.91	44,710	99.74	7,127	99.83	7,632	99.82
1 outpatient visit	6	0.07	102	0.23	12	0.17	11	0.14
>1 outpatient visit, no hospitalization	1	0.01	13	0.03	0	0.00	3	0.04
≥1 outpatient visit and/or hospitalization	1	0.01	3	0.01	0	0.00	0	0.00

* First time attendees starting airborne training 10/1/1998 -12/1/2006.

† Last recorded jump week training dates corresponding to PAB Protocol were as follows: Brace I 10/1/1998 to 9/30/2000, No brace I 10/1/2000 to 7/4/2005, Brace II (Co A & B) 7/5/2005 to 12/11/2006, No brace II (Co C & D) 7/5/2005 to 12/11/2006.

‡ Hospitalization or outpatient appointment occurring during a 14 day period from the start of latest jump week through the week following airborne training.

§ Overall chi-square p-value <0.0001

Ankle Injury Model

Unadjusted Poisson regression of brace use on ankle injury, using the No Brace I period as referent, indicates a reduction in risk during both brace periods (Brace I: 0.56, 95% CI 0.45 - 0.71; Brace II: 0.68, 95% CI 0.54 - 0.85). The No Brace II period yielded a rate ratio similar to the referent (data not shown). Rate ratios were similar after adjustment for age at start of training, rank, duration of service, ankle injury during the previous year, non-ankle injury during the previous year and Turnback during training (Brace I 0.60, 95% CI 0.47 – 0.75 and Brace II 0.62, 95% CI 0.49 – 0.78) compared to the referent No Brace I period (Table 3.4). After adjustment for start of training, rank, duration of service, ankle injury previous year, any non-ankle injury previous year, and Turnback during training, risk of ankle injury was similar during No Brace II compared with the referent period, No Brace I (0.94, 95% CI 0.78 – 1.14). Rate ratios for the ankle brace protocol periods were stable throughout the entire modeling process, suggesting little or no confounding. (See complete final model in Appendix B.).

Non-ankle Injury Model

The unadjusted risk of non-ankle injuries was lower during the first period of PAB use compared to No Brace I (rate ratio=0.74, 95% CI 0.64-0.84), but the two later brace use periods yielded rate ratios close to unity compared with No Brace I (data not shown). After adjustment for age at start of training, rank, duration of service, ankle injury during the previous year, non-ankle injury during the previous year and Turnback during training, the risk of non-ankle injuries was lower during both Brace I (0.77, 95% CI 0.68 – 0.88),and No Brace II (0.86, 95% CI 0.75 – 0.97) compared to the referent No Brace I (Table 3.4, see complete final model in Appendix C). No confounding by excluded covariates was observed.

Vertebral Column Injury (VCI) Model

The unadjusted risk of VCI was lower during Brace I (0.40, 95% CI 0.18-0.85) compared to No Brace I, but Brace II and No Brace II VCI rates were no different than the rates during No Brace I (data not shown). After controlling for age at start of training, non-ankle injury during the previous year and Turnback during training, the risk of VCI was lower during the first PAB use period (RR=0.42, 95% CI 0.19 – 0.90), while risks during the later two periods (Brace II and No Brace II) were not significantly different than the referent (Table 3.4, see complete final model in Appendix D.) No confounding by excluded covariates was observed.

Table 3.4. Multivariable Models for Selected Injuries[*] Among U.S. Army Airborne School Male Trainees,[†] 1998-2006 (n=68,418)

	Ankle injury[‡]		Non-ankle injury[§]		Vertebral column injury[**]		Musculoskeletal injury[††]		Lower extremity injury[‡‡]		Knee injury[§§]	
PAB[***]	Rate ratio	95% CI	Rate ratio	95% CI	Rate ratio	95% CI	Rate ratio	95% CI	Rate ratio	95% CI	Rate ratio	95% CI
Brace I	0.60	0.47-0.75	0.77	0.68-0.88	0.42	0.19 - 0.90	0.68	0.54-0.87	0.68	0.52-0.88	0.35	0.17-0.71
No Brace I (referent)	1.00		1.00		1.00		1.00		1.00		1.00	
Brace II	0.62	0.49-0.78	0.92	0.81-1.05	0.95	0.55 - 1.65	0.81	0.64-1.03	0.93	0.73-1.18	0.59	0.33-1.07
No Brace II	0.94	0.78-1.14	0.86	0.75-0.97	1.08	0.65-1.79	0.79	0.63-1.00	0.79	0.62-1.01	0.65	0.37-1.13

[*] Hospitalization or outpatient appointment occurring during a 14 day period from the start of latest jump week through the week following airborne training.

[†] First time attendees starting airborne training 10/1/1998 -11/27/2006.

[‡] Ankle injury rate ratios adjusted for age at start of training, rank, duration of service, ankle injury previous year, any non-ankle injury previous year, turned back during Airborne training.

[§] Non-ankle rate ratios adjusted for age at start of training, rank, duration of service, ankle injury previous year, any non-ankle injury previous year, turned back during Airborne training.

[**] VCI rate ratios adjusted for age at start of training, any non-ankle injury previous year, turned back during Airborne training.

[††] Musculoskeletal injury rate ratios adjusted for age at start of training, ankle injury previous year, any non-ankle injury previous year, turned back during Airborne training.

[‡‡] Lower extremity injury rate ratios adjusted for age at start of training, ethnicity, duration of service, any non-ankle injury previous year, turned back during Airborne training.

[§§] Knee injury rate ratios adjusted for age at start of training, any non-ankle injury previous year, turned back during Airborne training.

[***] Last recorded jump week training dates corresponding to PAB Protocol were as follows: Brace I 10/1/1998 to 9/30/2000, No brace I 10/1/2000 to 7/4/2005, Brace II (Co A & B) 7/5/2005 to 12/11/2006, No brace II (Co C & D) 7/5/2005 to 12/11/2006.

Musculoskeletal Injury Model

The unadjusted risk of musculoskeletal injuries was lower during Brace I (0.65, 95% CI 0.51-0.83) than No Brace I, and there was no statistically significant difference in the risk during No Brace I and the two later brace use periods (data not shown). After adjustment for age at start of training, ankle injury during the previous year, non-ankle injury during the previous year, and Turnback during training, the risk of musculoskeletal injury was statistically significantly lower during Brace I compared to No Brace I (RR= 0.68, 95% CI 0.54 - 0.87), but there were no differences between the risks during No Brace I and those during Brace II (RR=0.81, 95%CI 0.64 - 1.03) or No Brace II (RR= 0.79, 95% CI 0.63 - 1.00; Table 3.4 see complete final model in Appendix E). No confounding by excluded covariates was observed.

Lower Extremity Injury Model

The unadjusted risk of lower extremity injuries was lower during Brace I compared to No Brace I (RR=0.66, 95% CI 0.51 - 0.85), and there were no significant differences between the risk during No Brace I and the risks during the two later brace periods (data not shown). After adjustment for age at start of training, race/ethnicity, duration of service, non-ankle injury during the previous year, and Turnback during training, the risk of lower extremity injuries was lower during Brace I compared to No Brace I (RR=0.68, 95% CI 0.52 - 0.88), while the latter two brace periods (Brace II and No Brace II) were not statistically significantly different than the referent (Table 3.4, see complete final model in Appendix F). No confounding by excluded covariates was observed.

Knee Injury Model

The unadjusted Poisson regression analysis showed a reduction in risk of knee injuries during the Brace I period compared to No Brace I (RR=0.35, 95% CI 0.17 - 0.71). The two later brace periods (Brace II and No Brace II) were not statistically significantly different than the referent (data not shown). After adjustment for age at start of training, non-ankle injury during previous year, and Turnback during training, the risk of knee injury was statistically significantly lower during Brace I compared to No Brace I, (RR= 0.35, 95% CI 0.17 - 0.71), but the reduction in risk during Brace II compared to the referent was not statistically significant (RR=0.59, 95%CI 0.33 - 1.07). Similarly, the risk of knee injury was lower during No Brace II compared to No Brace I, but the reduction was not statistically significant (RR= 0.65, 95% CI 0.37 - 1.13). (Table 3.4, see complete final model in Appendix G). No confounding by excluded covariates was observed.

ROC Curves

ROC (Receiver Operating Characteristic) curves were plotted for each model to assess its ability to discriminate between trainees at higher vs. lower risk of injury. The area under the curve was 0.65 for ankle injury (fig 3.2), 0.64 for non-ankle injury (fig 3.3), 0.61 for vertebral column injury (fig 3.4), 0.63 for musculoskeletal injury (fig 3.5), 0.63 for lower extremity injury (fig 3.6), and 0.64 for knee injury (fig 3.7). These results indicate less than acceptable discrimination for each, and that important predictors of each injury may be missing. Nonetheless, because brace use was assigned by training class, without regard to predictors of injury, the difference in risk of injury for the brace periods compared to the no brace period remains a valid estimate of the protective effect of the brace.

Figure 3.2. ROC Curve for ankle injury during 2 week risk period
Area under the curve = 0.645

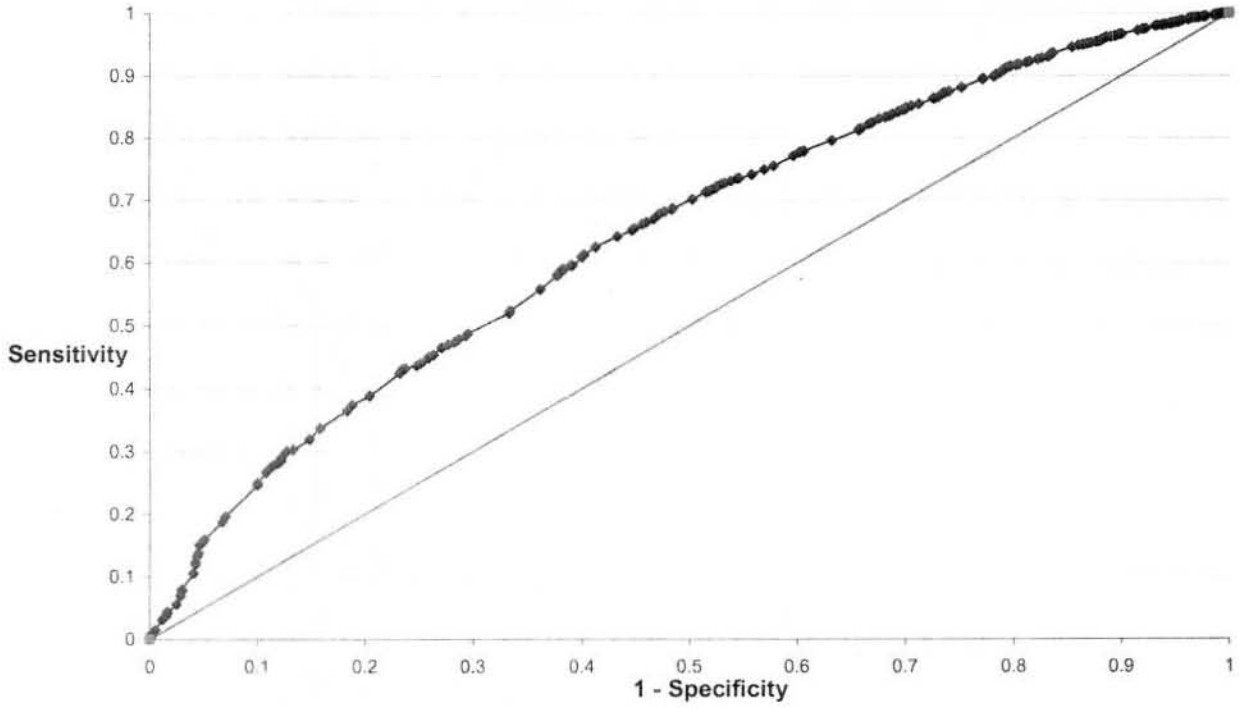


Figure 3.3. ROC Curve for non-ankle injury during 2 week risk period
Area under the curve = 0.640

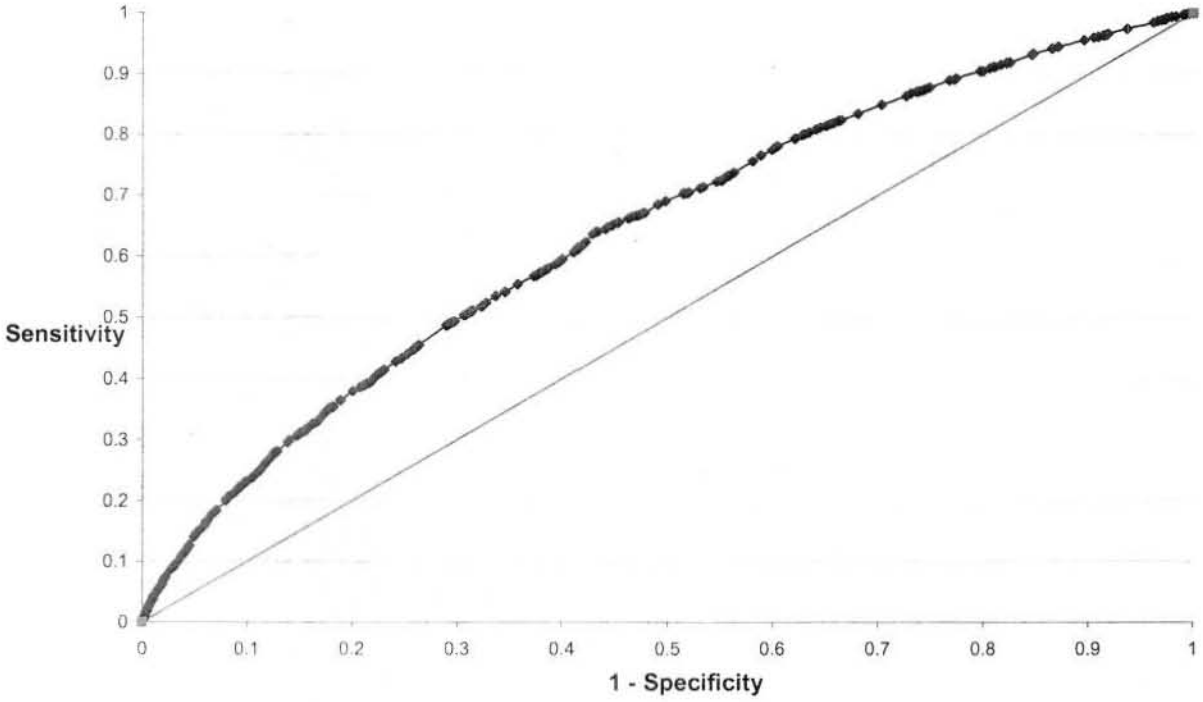


Figure 3.4. ROC Curve for vetebral column injury during 2 week risk period
Area under the curve = 0.613

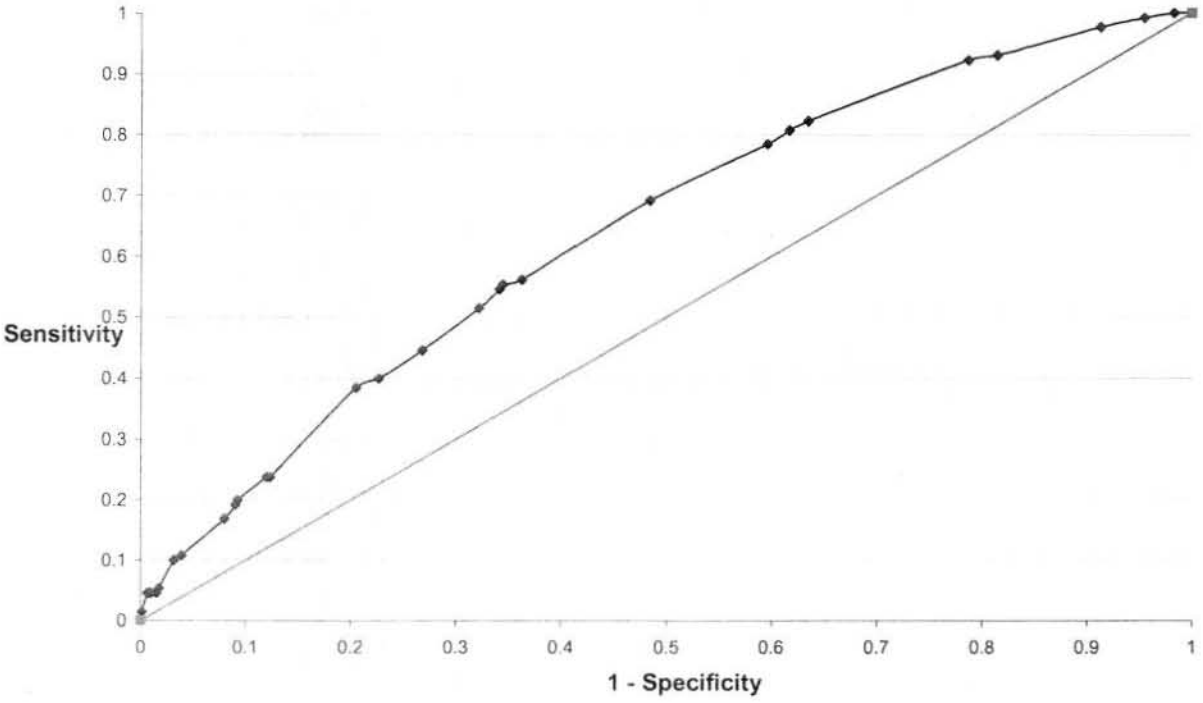


Figure 3.5. ROC Curve for musculoskeletal injury during 2 week risk period
Area under the curve = 0.630

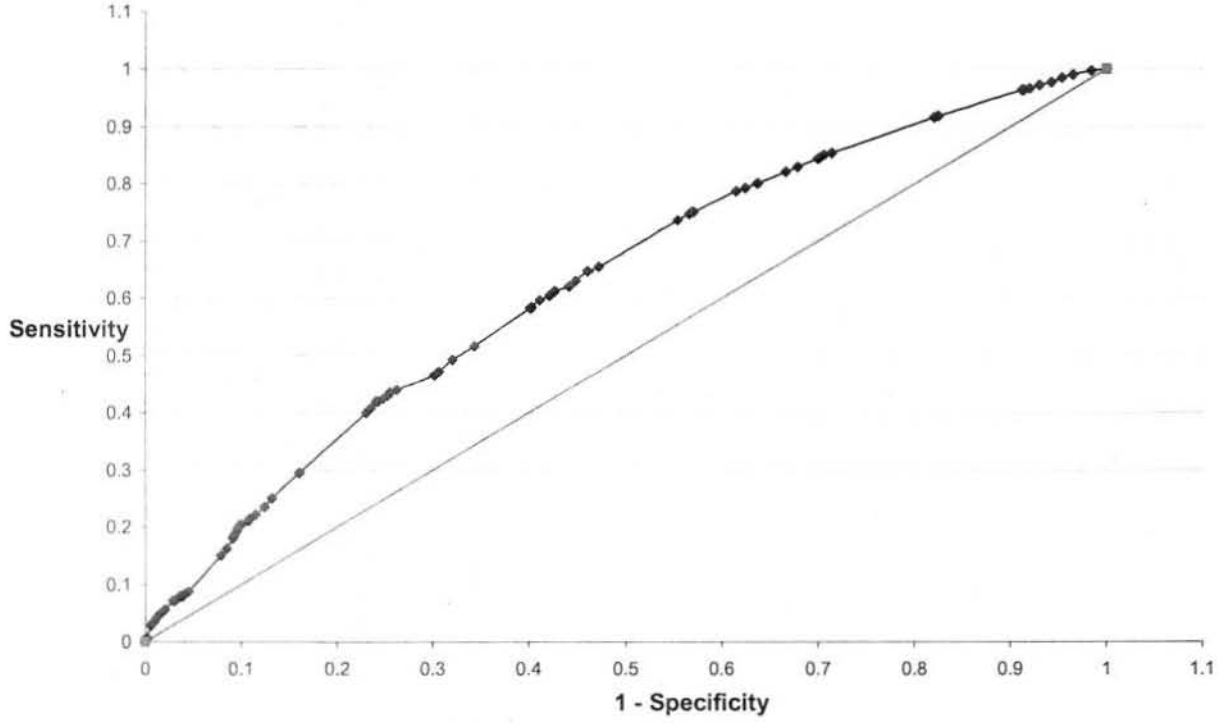


Figure 3.6. ROC Curve for lower extremity injury (non-ankle) during
2 week risk period, Area under the curve = 0.629

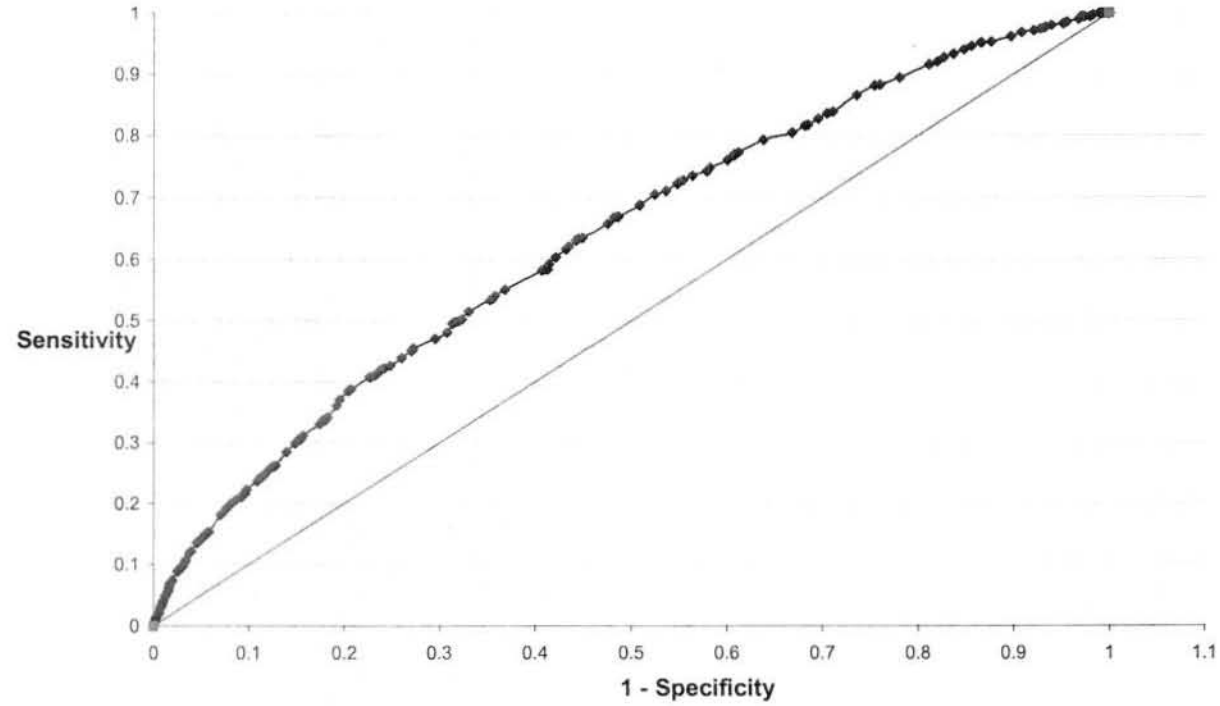
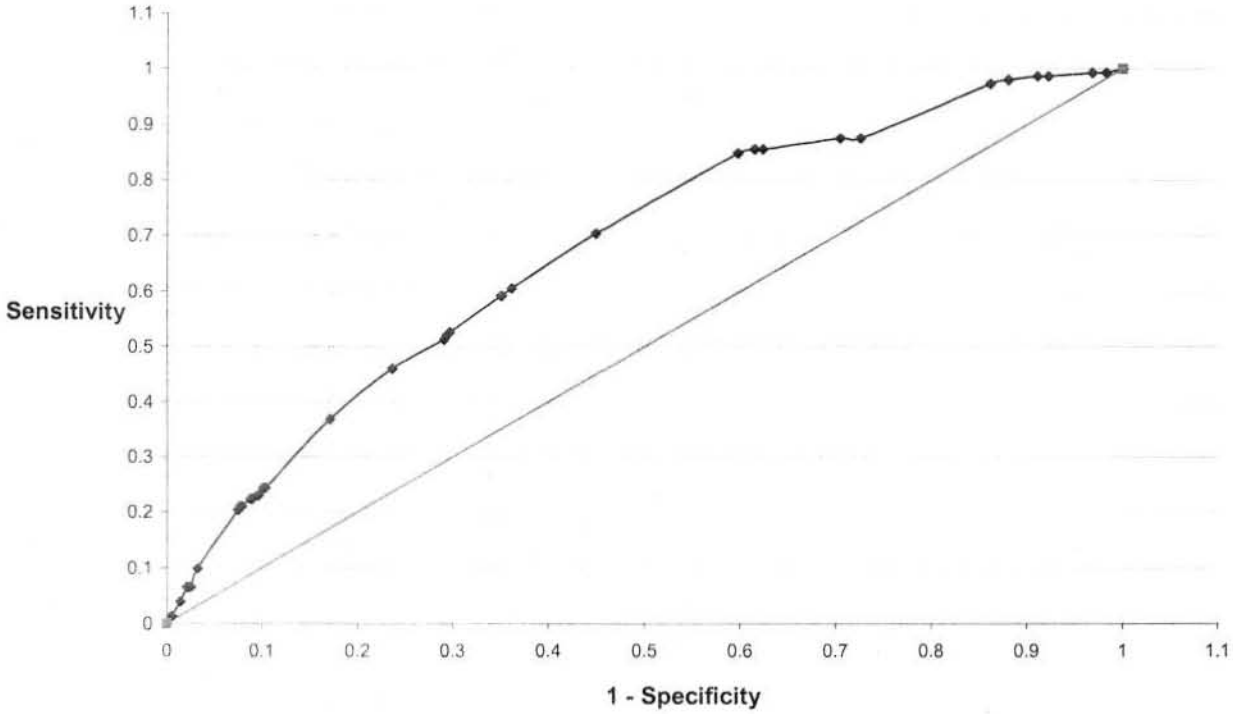


Figure 3.7 **ROC Curve for knee injury during 2 week risk period**
Area under the curve = 0.643



DISCUSSION

This evaluation of the effectiveness of the PAB in prevention of injury included two general, multi-site outcomes (any non-ankle injury, and musculoskeletal injury) and several specific anatomical site outcomes (ankle, other lower extremity, knee, and vertebral column injury). Results demonstrate that the PAB is effective at reducing the risk of ankle injury during parachute training, without a concomitant increase in injury risk for other specific body sites. Furthermore, there was no evidence of increased risk of non-ankle injury or musculoskeletal injury while wearing the brace. Among the small numbers of trainees who did experience parachuting related ankle, vertebral column, non-ankle musculoskeletal or lower extremity injuries or knee injuries, use of the PAB appeared unrelated to severity according to a rough scale based on location of treatment delivery.

This study corroborates previous investigations that identified reduced risk of ankle injury when the PAB is used during Airborne training (7, 10) with no accompanying increase in the risk of other injuries (2, 7, 8, 11). Of particular note, Schmidt et al. (10) described results suggesting a small magnitude increase in risk of vertebral column injuries requiring hospitalization associated with brace use based on a small number of cases (6 cases were trained during the brace period, 8 during the post-brace period). The present analyses did not support an increase in risk for vertebral column injuries (inpatient and outpatient events, combined) associated with use of the ankle brace: After adjustment for covariates, the relative risks compared to No Brace I were for 0.42 (95% CI 0.19 - 0.90) based on 7 cases during Brace I; 0.95 (95% CI 0.55 - 1.65) based on 15 cases in the Brace II period, and 1.08 (95% CI 0.65 - 1.79) based on 18 cases in the No Brace II period. There were 90 VCI cases recorded during No Brace I.

The main limitations of this analysis stem from the use of time rather than number of training jumps as the measure of exposure, as well as the general limitations associated with the use of an administrative database. The roster database contains only the most recent status for each trainee, so data for trainees with interruptions during the program were updated by overwriting earlier entries. This introduced the potential for missing injury data.

Because the risk period was defined as beginning with the latest jump week, medical encounters that occurred during an earlier attempt to complete jump week and resulted in a delay in training (Turnback) would have been missed as training-related outcomes, although they would have been identified as occurring during the year preceding training. Thirty trainees had injuries during the two weeks immediately preceding their latest jump week. Among these, the most common injuries were non-ankle (n=21), lower leg including ankle (n=11), and ankle only (n=7). Of the seven with ankle injury, four had evidence of medical treatment for ankle injury during the designated two week risk period. We could not ascertain whether these injuries were sustained exclusively from prior jump week activities that resulted in Turnback; some

injuries may have occurred during the land-based training portion of the program. A separate analysis of men entering the Airborne School is presented in section 5.

The student roster data file did not supply the actual number of jumps a trainee completed. Though successful completion of the program required five jumps, jump week injuries could have occurred at any point, including but not limited to, any actual descent. Lacking more precise data, we would have considered these injuries to be parachuting-related, although they might have occurred during other activities. As a result, the denominators of the rates were not necessarily comparable, because the total number of jumps completed by any trainee could not be known. Furthermore, a trainee who had been turned back during his initial rotation in jump week could have been returned to the program and completed more than five jumps, thereby having a higher chance of experiencing a parachuting-related injury than trainees who had not been turned back. Though the actual number of these instances is unknown, they are likely small: 115 of the 2,270 trainees that were turned back (for both medical and non-medical reasons) during jump week had ankle injuries designated as jump-related.

Injuries occurred rarely in this large population of trainees (1.5% had ankle injuries, and 3.6% had non-ankle injuries), which presented challenges with modeling. Because our fitted or predicted values were very small for each model, conventional assessments of model fit became invalid (1). The ROC curves showed poor discrimination, indicating that each model did not predict the particular injury well, and that some covariates may be missing from the models. Rate ratios for the ankle brace protocol periods for each model were stable throughout the entire modeling process, indicating little control of potential confounding, either because little confounding exists, or because important confounders were not included in the model. The goal of this study was to evaluate the effectiveness of the PAB in reducing injury, not to predict injury, however. As such, our finding of reduced risk of ankle injury associated with brace use remains valid because brace use was assigned by training class and/or time period, without regard to predictors of injury. In spite of the small number of injuries available for analysis, the large cohort size enabled useful analyses.

This extension to the investigation by Schmidt et al (10) features several improvements over the original design. First, by expanding the case definition to include events from episodes of care in the outpatient setting, we were able to assess the effect of PAB use on less severe injuries rather than limiting the analysis to fractures, dislocations, sprains, and strains requiring hospitalization. We also modified the cohort definition to omit from analysis trainees who left the program before advancing to jump week. This modification should yield a more accurate estimate of risk among those eligible to complete actual parachute descents.

OBJECTIVE 2: SENSITIVITY ANALYSIS

The purpose of this analysis was to ascertain whether the assessment of the effectiveness of the PAB in reducing the risk of injuries was sensitive to a change in the definition of the risk period.

METHODS

This analysis cohort was similar to the male cohort described in the previous section. The focus of this analysis, however, was on injuries incurred during the *earliest* jump week. Consequently, 577 trainees (0.8%) were omitted from this analysis because we were not able to ascertain the earliest jump week date from the available data. The sensitivity analysis cohort comprised 67,841 male trainees.

Brace Protocol Period Classification

Classification of brace protocol period for the sensitivity analysis was based on the *earliest* jump week date on record. Because the roster database represents the latest information for trainees with interruptions in training, information on each trainee's initial advancement to jump week was less complete.

Risk Period

The risk period for the sensitivity analysis was defined as a two week period beginning with the first day of the *earliest* identifiable jump week. Injuries occurring during this risk period were considered parachute-related.

RESULTS

Descriptive Statistics

- The distribution of demographic and occupational characteristics across PAB protocol categories was essentially unchanged compared to the male cohort (Table 4.1);
- Largest differences were seen for the composite variable representing Turnback status and injury during the year preceding training;
- Sensitivity analysis results show slightly lower proportions of trainees in each PAB protocol period for the stratum representing trainees with both Turnback and previous injury (ranging from 0.7% to 1.1% lower).

Table 4.1. Sensitivity Analysis: Descriptive Characteristics and Selected Outcomes of U.S. Army Airborne School Male Trainees* by Parachute Ankle Brace (PAB) Protocol, 1998-2006 (n=67,841)

	PAB Protocol							
	Brace I † (N = 8,741)		No brace I † (N = 44,514)		Brace II † Co A & B (N = 7,008)		No brace II † Co C & D (N = 7,578)	
	N	%	N	%	N	%	N	%
Age at start of training (yrs), quintiles								
17-18	1,815	20.8	8,805	19.8	1,198	17.1	1,218	16.1
19	2,281	26.1	9,988	22.4	1,297	18.5	1,380	18.2
20-21	2,157	24.7	10,035	22.5	1,553	22.2	1,751	23.1
22-23	1,369	15.7	7,072	15.9	1,187	16.9	1,373	18.1
24-44	1,119	12.8	8,614	19.4	1,773	25.3	1,856	24.5
Race/ethnicity								
White	6,285	71.9	33,228	74.7	5,420	77.3	5,757	76.0
Black	926	10.6	3,920	8.8	486	6.9	580	7.7
Hispanic	1,028	11.8	5,138	11.5	763	10.9	830	11.0
Other	502	5.7	2,228	5.0	339	4.8	411	5.4
Rank								
Enlisted (E-1 to E-9)	8,132	93.0	41,481	93.2	6,367	90.9	6,882	90.8
Officer/Warrant Officer	609	7.0	3,033	6.8	641	9.2	696	9.2
Duration of service (yrs), quintiles								
0 to 16 weeks	1,798	20.6	9,312	20.9	1,310	18.7	1,668	22.0
17 to 19 weeks	1,829	20.9	8,281	18.6	1,842	26.3	1,715	22.6
20 to 24 weeks	2,328	26.6	9,443	21.2	1,039	14.8	1,089	14.4
25 to 36 weeks	2,025	23.2	8,664	19.5	1,109	15.8	1,127	14.9
37 weeks to 8 yrs	761	8.7	8,814	19.8	1,708	24.4	1,979	26.1
Ankle Injury‡								
No	8648	98.9	43,704	98.2	6,936	99.0	7,439	98.2
Yes	93	1.1	810	1.8	72	1.0	139	1.8
Prior Ankle Injury‡								
No	7754	88.7	39,405	88.5	6,410	91.5	6,887	90.9
Yes	987	11.3	5,109	11.5	598	8.5	691	9.1
Prior Non-Ankle Injury‡								
No	5824	66.6	29394	66	4,571	65.2	5,041	66.5
Yes	2917	33.4	15,120	34.0	2,437	34.8	2,537	33.5
Turn back & previous injury past year								
No TB or previous injury	4489	51.4	23,260	52.3	3,708	52.9	4,055	53.5
Previous injury only	3483	39.7	17,751	39.9	2,524	36.0	2,673	35.3
TB only	319	3.7	1,543	3.5	352	5.0	394	5.2
Both TB and previous injury	450	5.2	1,960	4.4	424	6.1	456	6.0

Table 4.1. Sensitivity Analysis: Descriptive Characteristics and Selected Outcomes of U.S. Army Airborne School Male Trainees* by Parachute Ankle Brace (PAB) Protocol, 1998-2006 (n=67,841)

	PAB Protocol							
	Brace I † (N = 8,741)		No brace I † (N = 44,514)		Brace II † Co A & B (N = 7,008)		No brace II † Co C & D (N = 7,578)	
	N	%	N	%	N	%	N	%
Failed to graduate								
No	8672	99.2	43,925	98.7	6,966	99.4	7,502	99.0
Yes	69	0.8	589	1.3	42	0.6	76	1.0

† *Earliest* recorded jump week training dates corresponding to PAB Protocol were as follows: Brace I 10/1/1998 to 9/30/2000, No brace I 10/1/2000 to 7/4/2005, Brace II (Co A & B) 7/5/2005 to 12/11/2006, No brace II (Co C & D) 7/5/2005 to 12/11/2006

‡ Injury during risk period: defined as a two week period beginning with the first day of the *earliest* jump week.

Ankle injury model

A Poisson regression model was developed ("Sensitivity Model") using the same techniques for variable selection described in the previous section ("Male Model"). Table 4.2 presents the estimates derived from the Sensitivity Model along with risks estimated from a model containing the same variables selected for the Male Model. A summary of this comparison:

- The Sensitivity Model contains fewer covariates: age at start of training, rank, non-ankle injury during previous year, and Turnback during training;
- The Male Model additionally contains duration of service, and ankle injury during previous year;
- Rate ratios for PAB categories for the Sensitivity Model are similar to results for the Male Model (see Table 4.2);
- The same pattern of association is evident for the Sensitivity Model and the Male Model: Brace I and Brace II categories show a statistically significantly lower risk of ankle injury compared to risks recorded during No Brace I, though the Sensitivity Model shows a greater reduction in risk during the Brace II compared to No Brace I category (RR=0.51 vs. RR=0.62 for the Male Model);
- A model containing the same covariates as those included in the Male Model yields nearly identical rate ratios and confidence intervals to those calculated for the Male cohort;
- The largest differences in risk of ankle injury between the Sensitivity Cohort and the Male Cohort are evident for oldest age category (RR=2.06 vs. RR=1.95, Sensitivity and Male models, respectively) and Officer/Warrant Officer paygrades (RR=1.53 vs. RR=1.47, respectively).

Table 4.2 Sensitivity Analysis: Poisson Regression, Ankle Injury Outcome. Comparison of Final Sensitivity Cohort Model and Male Cohort Model on Sensitivity Cohort, n=67,841

	Final Sensitivity Cohort Model			Male Cohort Model Variables		
	Rate ratio	95% CI	p-value	Rate ratio	95% CI	p-value
PAB protocol *						
Brace I	0.59	0.48-0.74	<0.0001	0.61	0.49-0.76	<0.0001
No Brace I	1.00	-ref-	-	1.00	-ref-	-
Brace II	0.51	0.40-0.64	<0.0001	0.50	0.39-0.64	<0.0001
No Brace II	0.90	0.75-1.08	0.2508	0.89	0.74-1.06	0.1962
Age at start of training						
17-18	1.00	-ref-	-	1.00	-ref-	-
19	1.17	0.94-1.45	0.1671	1.16	0.93-1.45	0.178
20-21	1.52	1.23-1.86	<0.0001	1.48	1.20-1.82	0.0002
22-23	1.59	1.27-1.98	<0.0001	1.55	1.24-1.93	0.0001
24-44	2.06	1.68-2.53	<0.0001	1.95	1.58-2.40	<0.0001
Rank						
Enlisted (E1-E9)	1.00	-ref-	-	1.00	-ref-	-
Officer/Warrant Officer	1.53	1.26-1.86	<0.0001	1.47	1.20-1.79	0.0002
Non-Ankle Injury during previous year						
No	1.00	-ref-	-	1.00	-ref-	-
Yes	1.2118	1.07-1.37	0.0018	1.19	1.06-1.35	0.0048
Turned Back						
No	1.00	-ref-	-	1.00	-ref-	-
Yes	3.16	2.74-3.64	<0.0001	3.16	2.75-3.64	<0.0001
Duration of service				1.00	-ref-	-
0 to 16 wks				0.97	0.80-1.17	0.7505
17-19 wks				0.86	0.71-1.05	0.1385
20-24 wks				0.85	0.70-1.04	0.1136
25-36 wks				1.11	0.92-1.33	0.2763
37 wks to 8 yrs						
Ankle Injury during previous year						
No				1.00	-ref-	-
Yes				1.17	0.98-1.39	0.0753

**Earliest* recorded jump week training dates corresponding to PAB Protocol were as follows: Brace I 10/1/1998 to 9/30/2000, No brace I 10/1/2000 to 7/4/2005, Brace II (Co A & B) 7/5/2005 to 12/11/2006, No brace II (Co C & D) 7/5/2005 to 12/11/2006

DISCUSSION

Changing the definition of risk period did not alter the association between ankle injury and brace use. Point estimates and confidence intervals were essentially unchanged for the Sensitivity Model compared to the Male Model, and a protective effect against ankle injuries persisted for the Brace I and II periods. This analysis corroborates the conclusions of the main analysis, that the PAB is an effective means of reducing the risk of ankle injuries occurring during parachute training.

OBJECTIVE 3: ENTRY COHORT

The primary analysis (Objective 1) was limited to trainees who advanced to jump week. In the Entry Cohort, we evaluated injuries experienced by trainees who left Airborne training during ground and tower weeks. This cohort included graduates and non-graduates, as well as trainees who experienced interruption(s) (e.g., Turnback) during training.

METHODS

Cohort Enumeration

This cohort included men who entered Airborne School, regardless of whether they advanced beyond the first week of training. This allowed assessment of injury during the first two weeks of training (i.e., ground and tower weeks) prior to jump week. The following exclusions were made, in addition to the initial basic exclusions: 39 trainees were missing duration of service data, 4,405 were female, 77 had ambiguous records that did not allow accurate categorization, 193 trainees left Airborne training before ground week, and 1,628 trainees started Airborne training after the end of the study period (fig 2.1). The entry cohort comprised 78,406 trainees.

Brace Protocol Period Classification

Because this analysis also includes trainees who left Airborne training before jump week, PAB protocol classification was not meaningful and was not used in analysis.

Risk Period

The purpose of this analysis was to evaluate injury during the entire Airborne training experience; consequently, the risk period for the Entry Cohort was defined as beginning on the first day of Airborne School and ending with the last day of training. The latter date was not available directly from the roster data file, but was ascertained, to the extent possible, from available disposition data that indicated interruptions in training as well as reasons for interruptions. Risk period lengths were defined according to the maximum identifiable training interval: 7 days for trainees who left the program during the first week ("ground" week); 14 days for those who left during the second week ("tower" week); and 21 days for those who advanced to jump week. Risk periods were longer for those with evidence of Turnback(s) as these gaps in training were considered part of the risk period. Table 6.1 shows the distribution of length of risk periods for this cohort.

RESULTS

Overall, 22.3% (17,516/78,406) of trainees had some type of interruption in training: 8.3% were due to Turnbacks (6539/78,406), and 13.6 % (10,646/78,406) failed to graduate. Demographic characteristics, stratified by length of time in training, are presented in Tables 5.1.

- 12.7% (9,988/78,406) of males entering Airborne School left the program during the first two weeks.
- The age and race/ethnicity distributions were similar between trainees who left training before jump week and those who advanced to jump week.
- Those advancing to jump week had longer duration of service.
- More officers than enlisted trainees advanced to jump week (7.3% vs. 2.8%, respectively).
- 11% (7,528/68,418) of those who advanced to jump week experienced some type of interruption during the first two weeks of training, and 6,539 of these were Turnbacks (9.6% of 68,418), indicating eventual graduation from the program.
- Ankle injury during Airborne School was more common for trainees who left before jump week (4.9% vs. 1.8%, respectively) than for trainees who remained in Airborne into jump week.
- Trainees who left Airborne School prior to jump week were more likely to have had any type of injury during the previous year than trainees who advanced to jump week (57.9% vs. 43.2%, respectively).

Table 5.1. Male Entry Cohort: Descriptive Characteristics of U.S. Army Airborne School Trainees * by Progress in Training 1998-2006 (n=78,406)

Characteristic	Left AB before jump week (N=9988) N	%	Advanced to jump week (N = 68,418) N	%
Age at start of training (yrs), quintiles				
17-18	2,018	20.2	13,142	19.2
19	2,395	24.0	15,060	22.0
20-21	2,373	23.8	15,640	22.9
22-23	1,400	14.0	11,080	16.2
24-44	1,802	18.0	13,496	19.7
Race/ethnicity				
White	7,644	76.5	51,113	74.7
Black	986	9.9	5,962	8.7
Hispanic	890	8.9	7,830	11.4
Other	468	4.7	3,513	5.1
Rank				
Enlisted (E-1 to E-9)	9,709	97.2	63,418	92.7
Officer/Warrant Officer	279	2.8	5,000	7.3
Duration of service (yrs), quintiles				
0 to 16 weeks	1,679	16.8	14,235	20.8
17 to 19 weeks	2,090	20.9	13,804	20.2
20 to 24 weeks	2,518	25.2	13,028	19.0
25 to 36 weeks	2,279	22.8	13,204	19.3
37 weeks to 8 yrs	1,422	14.2	14,147	20.7
Any type of interruption during training	9,988	100.0	7,528	11.0
TurnBack during training	0	0	6,539	9.6
Failed to graduate	9,828	98.4	818	1.2
Risk period† length				
1 week	7,098	71.1	0	0
1 week + delay	1,579	15.8	0	0
2 weeks	1,130	11.3	0	0
2 weeks + delay	181	1.8	0	0
3 weeks	0	0	60,890	89.0
3 week + delay	0	0	7,528	11.0
Ankle injury during risk period[c]	487	4.9	1,223	1.8
Any injury during year prior to AB training	5,783	57.9	29,580	43.2

* First time attendees starting airborne training 10/1/1998 -11/27/2006.

† Risk period definition: 1st day of Airborne training to best estimate of end of training.

Table 5.2 contains selected program descriptives for the 17,516 trainees who experienced some sort of interruption in training.

- 39% of men who entered Airborne School eventually graduated.
- The most frequent type of interruption was temporary disqualification (46%).
- 37% of interruptions were due to Turnback
- Nearly 15% of interruptions in training were due to permanent disqualification.
- Most interruptions (67%) occurred during the 1st week of training (ground week).
- The most common reasons for interruption were physical training failure (31%) and medical reasons (29%).

Table 5.2 Male Entry Cohort: Airborne Program Outcomes for 17,516 U.S. Army Airborne School Trainees with Program Interruption(s), 1998-2006, (22% of n=78,406 Cohort)

Roster characteristic	N	%
Training interrupted	17,516	22.30
Disposition outcome:*		
Turn back	6,539	37.30
Temporary disquialification	8,072	46.09
Permanent disqualification	2,574	14.70
Hold	330	1.88
Stage disqualified/Passed:		
Before†	9	0.09
Ground (week 1)	11,771	67.20
Tower (week 2)	2,477	14.14
Jump (week 3)	3,258	18.60
Reason for disqualification/Pass:		
Physical training failure	5,418	30.93
Medical	5,140	29.34
Administrative	3,016	17.22
Quit permanently	2,320	13.25
Qualified jumper	1,138	6.50
Failure to qualify‡	435	2.48
Refused to jump (mock tower, aircraft)	37	0.21
Hospital	8	0.05
Overweight	3	0.02
Disciplinary drop perm/temp	1	0.01
Graduated	6,870	39.22

* n=1 trainee was missing disposition outcome code, but had interruption duuring jump week and was retained in study

† n=9 trainees had interruption "before" ground week - but were retained in study because they were turned back and graduated

‡ swing landing trainer, mock tower, parachute landing falls, free tower

Table 5.3 presents the distribution of selected Airborne program descriptives by reason for interruption, among the17,516 trainees with interruption in training.

- The most common reasons for Turnbacks were administrative reasons (56.6%) or failure to qualify on specified apparatus (86.0%). These students eventually returned and completed the program.
- Physical training failure (68.1%) and medical (65.3%) reasons accounted for highest rates of temporary disqualification, which indicates non-completion of the current program.

- 6.5% (1,138/17,516) of the trainees with interruptions in training were designated Qualified Jumpers, indicating these trainees completed the program (personal communication, B. Morway, 8/7/2008).
- Physical training failure (98.0%) occurred most often during ground week, as did quit permanently (87.2%), medical (53.6%), and interruptions for administrative (47.1%) reasons.
- Failure to qualify on specified apparatus occurred almost equally frequently during ground and tower weeks (50.6% and 49.2%, respectively)
- 37 trainees refused to jump; half from mock tower during ground week, and half from aircraft during jump week.
- Among students who failed to graduate, the most common reasons were physical training failure (68.1%), medical (65.4%), and administrative (38.8%) reasons.
- Injury during previous year occurred among 40-60% of students in every category of training interruption.

Table 5.3. Male Entry Cohort: Selected Program and Injury Outcomes of U.S. Army Airborne School Trainees by Reason for Interruption in Training, 1998-2006 (n=17,516)

	Reason for Interruption																	
	Physical training failure (n=5,418)		Medical (n=5,140)		Adminis-trative (n=3,016)		Quit permanently (n=2,320)		Qualified jumper (n=1,138)		Failure to qualify[b] (n=435)		Refused to jump[c] (n=37)		Hospital (n=8)		Over-weight (n=3)		Disciplinary drop (n=1)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Disposition outcome:																				
TurnBack	1,726	31.9	1,686	32.8	1,707	56.6	0	0.0	1,046	92.0	374	86.0	0	0.0	0	0.0	0	0.0	0	0.0
Temporary disqualification	3,692	68.1	3,354	65.3	960	31.8	1	0.0	1	0.1	60	13.8	0	0.0	0	0.0	3	100.0	1	100.0
Permanent disqualification	0	0.0	8	0.2	209	6.9	2,319	99.9	0	0.0	1	0.2	37	100.0	0	0.0	0	0.0	0	0.0
Hold	0	0.0	92	1.8	140	4.6	0	0.0	90	7.9	0	0.0	0	0.0	8	100.0	0	0.0	0	0.0
Stage disqualified/ Passed:																				
Before[d]	0	0.0	3	0.1	6	0.2	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Ground week	5,308	98.0	2,754	53.6	1,421	47.1	2,024	87.2	23	2.0	220	50.6	18	48.7	0	0.0	3	100.0	0	0.0
Tower week	109	2.0	1,163	22.6	762	25.3	225	9.7	1	0.1	214	49.2	1	2.7	1	12.5	0	0.0	1	100.0
Jump week	1	0.0	1,220	23.7	827	27.4	71	3.1	1,114	97.9	0	0.0	18	48.7	7	87.5	0	0.0	0	0.0
Failed to graduate	3,692	68.1	3,362	65.4	1,169	38.8	2,320	100.0	1	0.1	61	14.0	37	100.0	0	0.0	3	100.0	1	100.0
Any injury during risk period	430	7.9	3,947	76.8	431	14.3	288	12.4	193	17.0	26	6.0	2	5.4	5	62.5	1	33.3	0	0.0
Any injury year prior to Airborne School	2,846	52.3	3,036	59.1	1,530	50.7	1,299	56.0	551	48.4	198	45.5	16	43.2	3	37.5	3	100.0	0	0.0

Type and/or site of injury was evaluated separately for students with interruptions during training (Table 5.4), students with Turnback status (Table 5.5), and according to graduation status (Table 5.6).

- Injury during the previous year was recorded for 54.1% of trainees with any type of interruption, 49.2% for those with Turnback only, and for 57.2% of non-graduates.
- Injury (any type) during the risk period was the second most frequent outcome for all three: 30.4% for trainees with any type of interruption, 25.5% for those with TurnBack only, and 33.1% for non-graduates.
- Table 5.4 shows higher rates of injury for trainees with any type of interruption, for each site/outcome considered.
- The same pattern emerged comparing students with and without Turnback status (Table 5.5), though differences for upper leg, abdomen, and spinal cord sites were not statistically significantly different for students with and without Turnback.
- Injury site stratified by graduation status (Table 5.6) showed higher rates of injury for each site/outcome among non-graduates compared to graduates, except for trunk and spinal cord injury sites: injury rates for these sites were not statistically significantly different for students who graduated vs. those who did not graduate.
- The same five sites/outcomes (injury during previous year, any type of injury, any traumatic (non-ankle) injury, non-injury hospitalization or outpatient visit, and lower leg) comprised 10% or more of injuries among trainees with interruption(s), trainees with Turnback, and non-graduates.
- For those with any type of interruption, Turnback, and for non-graduates, ankle injury comprised 7.94%, 8.17%, and 7.70% of injuries, respectively.

Table 5.4. Male Entry Cohort: Injury During Risk Period for U.S. Army Airborne School Trainee,* Sorted by Most Frequent Injuries Among Trainees with Any Type of Interruption(s) During Airborne Training, 1998-2006, (n=78,406)

	Any type of interruption† during AB training				
	Yes (N=17,516)		No (N=60,890)		Chi-Square
Outcome/Injury Site‡	N	%	N	%	p-value
Injury during 1 year prior to AB training	9,482	54.13	25,881	42.50	<0.0001
Any type of injury	5,323	30.39	1,379	2.26	<0.0001
Any traumatic (non-ankle) injury §	3,745	21.38	983	1.61	<0.0001
Non-injury hospitalization/outpatient visit **	3,346	19.10	2,961	4.86	<0.0001
Lower leg	2,195	12.53	413	0.68	<0.0001
Any lower extremity (non-ankle) injury	1,447	8.26	242	0.40	<0.0001
Ankle	1,390	7.94	320	0.53	<0.0001
Injury to multiple body parts ††	1,126	6.43	197	0.32	<0.0001
Musculoskeletal injury ‡‡	1,117	6.38	215	0.35	<0.0001
Other lower extremity	1,001	5.71	192	0.32	<0.0001
Any ankle procedure§§	418	2.39	133	0.22	<0.0001
Back	397	2.27	68	0.11	<0.0001
Foot	372	2.12	109	0.18	<0.0001
Ankle fracture ***	345	1.97	54	0.09	<0.0001
Knee	315	1.80	35	0.06	<0.0001
Shoulder	310	1.77	86	0.14	<0.0001
Pelvis	246	1.40	25	0.04	<0.0001
Hip	217	1.24	32	0.05	<0.0001
Other/multiple sites	189	1.08	91	0.15	<0.0001
Other head, face, neck	186	1.06	164	0.27	<0.0001
Vertebral column	166	0.95	56	0.09	<0.0001
Traumatic brain injury	153	0.87	70	0.11	<0.0001
Wrist	121	0.69	42	0.07	<0.0001
Chest (thorax)	70	0.40	18	0.03	<0.0001
Other upper extremity	54	0.31	18	0.03	<0.0001
Upper leg	54	0.31	15	0.02	<0.0001
Trunk	42	0.24	19	0.03	<0.0001
Forearm	40	0.23	32	0.05	<0.0001
Abdomen	8	0.05	6	0.01	0.005†††
Spinal cord	4	0.02	0	0.00	0.003†††
Ankle injury severity :					
1 outpatient visit	654	3.73	247	0.41	
>1 outpatient visit, no hospitalization	575	3.28	53	0.09	
≥1 outpatient visit and hospitalization	151	0.86	19	0.03	
Hospitalization only, no procedure	1	0.01	0	0.00	
Hospitalization and ankle procedure	9	0.05	1	0.00	<0.0001

* First time attendees starting airborne training 10/1/1998 -12/1/2006.

† Interruption: Turn back, temporary disqualification, permanent disqualification, or hold.

‡ Outcomes based on records for hospitalization or outpatient appointment(s) for specified injury, occurring during risk period from the start of AB training to end of AB training.

§ Any traumatic (non-ankle) injury includes both musculoskeletal (non-ankle) injury and soft-tissue injuries.

** A trainee could have both injury and non-injury hospitalization and/or outpatient visit(s)

†† Injury to multiple body parts overlaps with all other outcomes

‡‡ Musculoskeletal injury and any traumatic non-ankle injury outcomes include ICD codes also found in knee, hip, vertebral column, and lower extremity injuries, but not ankle.

§§ Any ankle procedure is based on CPT codes (not ICD-9 codes) and overlaps with ankle injury

*** Ankle fracture outcome is subset of ankle injury outcome

††† p-value from Fisher's exact test

Table 5.5. Male Entry Cohort: Injury During Risk Period for U.S. Army Airborne School Trainees*, Sorted by Most Frequent Injuries Among Trainees with TurnBack During Airborne Training, 1998-2006, (n=78,406)

	TurnBack during AB training				
	Yes		No		Chi-Square
	(N=6539)		(N=71,867)		
Outcome/Injury Site†	N	%	N	%	p-value
Injury during 1 year prior to AB training	3,219	49.23	32,144	44.73	<0.0001
Any type of injury	1,667	25.50	5,035	7.01	<0.0001
Non-injury hospitalization or outpatient visit ‡	1,566	23.95	4,741	6.60	<0.0001
Any traumatic (non-ankle) injury §	1215	18.58	3,513	4.89	<0.0001
Lower leg	719	11.00	1,889	2.63	<0.0001
Ankle	534	8.17	1,176	1.64	<0.0001
Injury to multiple body parts **	527	8.06	796	1.11	<0.0001
Other lower extremity	396	6.06	797	1.11	<0.0001
Any lower extremity (non-ankle) injury	382	5.84	1,307	1.82	<0.0001
Musculoskeletal injury ††	334	5.11	998	1.39	<0.0001
Foot	128	1.96	353	0.49	<0.0001
Any ankle procedure‡‡	120	1.84	431	0.60	<0.0001
Other head, face, neck	110	1.68	240	0.33	<0.0001
Back	106	1.62	359	0.50	<0.0001
Traumatic brain injury	102	1.56	121	0.17	<0.0001
Knee	98	1.50	252	0.35	<0.0001
Shoulder	95	1.45	301	0.42	<0.0001
Other/multiple sites	95	1.45	185	0.26	<0.0001
Ankle fracture §§	77	1.18	322	0.45	<0.0001
Pelvis	68	1.04	203	0.28	<0.0001
Hip	65	0.99	184	0.26	<0.0001
Vertebral column	64	0.98	158	0.22	<0.0001
Wrist	49	0.75	114	0.16	<0.0001
Chest (thorax)	34	0.52	54	0.08	<0.0001
Trunk	21	0.32	40	0.06	<0.0001
Other upper extremity	20	0.31	52	0.07	<0.0001
Forearm	14	0.21	58	0.08	0.0007
Upper leg	10	0.15	59	0.08	0.06
Abdomen	2	0.03	12	0.02	0.33***
Spinal cord	1	0.02	3	0.00	0.29***
Ankle injury severity :					
1 outpatient visit	156	2.39	745	1.04	
>1 outpatient visit, no hospitalization	351	5.37	277	0.39	
≥1 outpatient visit and hospitalization	27	0.41	143	0.20	
Hospitalization only, no procedure	0	0.00	1	0.00	
Hospitalization and ankle procedure	0	0.00	10	0.01	<0.0001

* First time attendees starting airborne training 10/1/1998 -12/1/2006.

† Outcomes based on records for hospitalization or outpatient appointment(s) for specified injury, occurring during risk period from the start of AB training to end of AB training.

‡ A trainee could have both injury and non-injury hospitalization and/or outpatient visit(s)

§ Any traumatic (non-ankle) injury includes both musculoskeletal (non-ankle) injury and soft-tissue injuries.

** Injury to multiple body parts overlaps with all other outcomes

†† Musculoskeletal injury and any traumatic non-ankle injury outcomes include ICD codes also found in knee, hip, vertebral column, and lower extremity injuries, but not ankle.

‡‡ Any ankle procedure is based on CPT codes (not ICD-9 codes) and overlaps with ankle injury

§§ Ankle fracture outcome is subset of ankle injury outcome

*** p-value from Fisher's exact test

Table 5.6. Male Entry Cohort: Selected Injury Outcomes for U.S. Army Airborne School Trainees,* Sorted by Most Frequent Injuries Among Non-graduates, 1998-2006, (n=78,406)

	Graduation Status				
	Yes (N=67,760)		No (N=10,646)		Chi-Square
Outcome/Injury Site†	N	%	N	%	p-value
Injury during 1 year prior to AB training	29,273	43.20	6,090	57.20	<0.0001
Any type of injury	3,177	4.70	3,525	33.10	<0.0001
Any traumatic (non-ankle) injury‡§	2,289	3.38	2439	22.91	<0.0001
Non-injury hospitalization or outpatient visit**	4,597	6.80	1,710	16.10	<0.0001
Lower leg	1,199	1.77	1,409	13.24	<0.0001
Any lower extremity (non-ankle) injury	663	0.98	1026	9.64	<0.0001
Ankle	896	1.30	814	7.70	<0.0001
Musculoskeletal injury§	583	0.86	750	7.04	<0.0001
Other lower extremity	611	0.90	582	5.47	<0.0001
Injury to multiple body parts††	758	1.12	565	5.31	<0.0001
Back	181	0.27	284	2.67	<0.0001
Any ankle procedure‡‡	275	0.41	276	2.59	<0.0001
Ankle fracture§§	155	0.23	244	2.29	<0.0001
Foot	246	0.36	235	2.21	<0.0001
Knee	139	0.21	211	1.98	<0.0001
Shoulder	189	0.28	207	1.94	<0.0001
Pelvis	101	0.15	170	1.60	<0.0001
Hip	103	0.15	146	1.37	<0.0001
Vertebral column	129	0.20	93	0.87	<0.0001
Other/multiple sites	198	0.29	82	0.77	<0.0001
Other head, face, neck	284	0.42	66	0.62	0.004
Wrist	97	0.14	66	0.62	<0.0001
Traumatic brain injury	180	0.27	43	0.40	0.01
Upper leg	27	0.04	42	0.39	<0.0001
Chest (thorax)	55	0.08	33	0.31	<0.0001
Other upper extremity	40	0.06	32	0.30	<0.0001
Forearm	46	0.07	26	0.24	<0.0001
Trunk	46	0.07	15	0.14	0.12
Abdomen	9	0.01	5	0.05	0.02
Spinal cord	3	0.00	1	0.01	0.44***
Ankle injury severity :					
1 outpatient visit	420	0.62	481	4.52	
>1 outpatient visit, no hospitalization	419	0.62	209	1.96	
≥1 outpatient visit and hospitalization	54	0.08	116	1.09	
Hospitalization only, no procedure	1	<0.1	0	0.00	
Hospitalization and ankle procedure	2	<0.1	8	0.08	<0.0001

* First time attendees starting airborne training 10/1/1998 -12/1/2006.

†Outcomes based on records for hospitalization or outpatient appointment(s) for specified injury, occurring during risk period from the start of AB training to end of AB training.

‡ Any traumatic (non-ankle) injury includes both musculoskeletal (non-ankle) injury and soft-tissue injuries.

§ Musculoskeletal injury and any traumatic non-ankle injury outcomes include ICD codes also found in knee, hip, vertebral column, and lower extremity injuries, but not ankle.

** A trainee could have both injury and non-injury hospitalization and/or outpatient visit(s).

†† Injury to multiple body parts overlaps with all other outcomes.

‡‡ Any ankle procedure is based on CPT codes (not ICD-9 codes) and overlaps with ankle injury.

§§ Ankle fracture outcome is subset of ankle injury outcome.

*** p-value from Fisher's exact test.

DISCUSSION

This analysis described trainees who left Airborne School prior to jump week. Their risk periods were redefined to capture all injuries occurring at any point during training. Overall, 78% (60,890/78,406) of trainees who started Airborne School completed the program in the scheduled three weeks, and 86% (67,760/78,406) of those who started the program eventually graduated. Over two-thirds of the interruptions occurred during ground week, and examination of reason for interruption revealed substantial retention and eventual graduation of trainees (via Turnback) for several categories: 86% of those who initially failed to qualify on specified apparatus, 57% with administrative reasons for interruption, 33% of those with medical reasons for interruption and 32% of students with physical training failure eventually graduated from the Airborne School.

Injury during the previous year was the most frequent injury outcome associated with interruption, Turnback, and failure to graduate, followed by the summary indicator for any type of injury during the risk period.

OBJECTIVE 4: INJURIES AMONG WOMEN TRAINEES

In this section, injuries experienced by women Airborne trainees are described. Women were evaluated separately because their injury risk profile is known to differ from men's and because they comprised only 3% of all trainees attending Airborne School during the study period.

METHODS

Cohort Enumeration

The evaluation of injury among women was conducted on women who advanced to jump week, regardless of whether they actually finished the training program. The selection of the female cohort was identical to that for the Male cohort (fig 2.1). The female analysis cohort comprised 2,261 trainees.

Brace Protocol Period Classification

Brace use category assignment was the same as for the male cohort, and was based on the class and company assignment corresponding to the date for the latest recorded jump week (see Table 2.1 brace protocol periods.)

Risk Period

The risk period was defined as a two week period beginning with the first day of the *latest* jump week on record.

RESULTS

Descriptive Statistics

Descriptive characteristics and selected injury outcomes by brace use category for the female cohort are found in Tables 6.1 and 6.2, respectively.

- Women who trained during the more recent brace periods (Brace II and No brace II) tended to be older, have longer duration of service, and were more frequently turned back during training;
- Women who attended training during non-brace use periods were somewhat more likely to be turned back during training and to have a history of injury during the previous year (14.1% for No Brace I and 11.6% for No Brace II, and 5.6% for Brace I and 8.7% for Brace II).
- 78 (3.4 % of cohort) ankle injuries occurred during the risk period.

- The risk of ankle injury was highest for the most recent time period, and similar for trainees who were assigned to brace use or non-use (4.37% and 4.70% for Brace II and No Brace II, respectively)
- Overall, relatively few injuries occurred, and no patterns of injury by brace use were evident.
- The small number of injuries precluded detailed analysis of women trainees.

Table 6.1. Descriptive Characteristics of U.S. Army Airborne School Female Trainees* by Parachute Ankle Brace (PAB) Protocol, 1998-2006 (n=2,261)

	PAB Protocol							
	Brace I † (N = 360)		No brace I † (N = 1330)		Brace II † Co A & B (N = 252)		No brace II † Co C & D (N = 319)	
	N	%	N	%	N	%	N	%
Age at start of training (yrs), quintiles								
17-18	65	18.1	227	17.1	28	11.1	44	13.8
19	103	28.6	280	21.1	48	19.1	50	15.7
20-21	63	17.5	261	19.6	48	19.1	52	16.3
22-23	70	19.4	281	21.1	38	15.1	68	21.3
24-39	59	16.4	281	21.1	90	35.7	105	32.9
Race/ethnicity								
White	208	57.8	766	57.6	148	58.7	198	62.1
Black	81	22.5	249	18.7	31	12.3	40	12.5
Hispanic	43	11.9	217	16.3	48	19.1	52	16.3
Other	28	7.8	98	7.4	25	9.9	29	9.1
Rank								
Enlisted (E-1 to E-9)	314	87.2	1,096	82.4	206	81.8	254	79.6
Officer/Warrant Officer	46	12.8	234	17.6	46	18.3	65	20.4
Duration of service, quintiles								
0 to 20 weeks	95	26.4	251	18.9	51	20.2	61	19.1
21 to 25 weeks	100	27.8	263	19.8	43	17.1	48	15.1
26 to 31 weeks	81	22.5	273	20.5	52	20.6	52	16.3
32 to 57 weeks	74	20.6	272	20.5	31	12.3	62	19.4
14 mths to 8 yrs	10	2.8	271	20.4	75	29.8	96	30.1
Turn back & previous injury past year								
No TB or previous injury	127	35.3	475	35.7	100	39.7	124	38.9
Previous injury only	205	56.9	579	43.5	120	47.6	140	43.9
TB only	8	2.2	88	6.6	10	4.0	18	5.6
Both TB and previous injury	20	5.6	188	14.1	22	8.7	37	11.6
Failed to graduate	5	1.4	22	1.6	6	2.4	5	1.6

* First time attendees starting airborne training 10/1/1998 -12/1/2006.

† Last recorded jump week training dates corresponding to PAB Protocol were as follows: Brace I 10/1/1998 to 9/30/2000, No brace I 10/1/2000 to 7/4/2005, Brace II (Co A & B) 7/5/2005 to 12/11/2006, No brace II (Co C & D) 7/5/2005 to 12/11/2006.

Table 6.2. Selected Injury Outcomes for U.S. Army Airborne School Female Trainees* Based on Inpatient & Outpatient Data, by Parachute Ankle Brace (PAB) Protocol, 1998-2006, PAB Extension Cohort (n=2,261)

	PAB Protocol								
	Brace I † (N = 360)		No brace I † (N = 1330)		Brace II † Co A & B (N = 252)		No brace II † Co C & D (N = 319)		Overall Chi-Square
Outcome	N	%	N	%	N	%	N	%	p-value
Ankle injury ‡	6	1.67	46	3.46	11	4.37	15	4.70	0.13
Ankle fracture §	2	0.56	13	0.98	1	0.40	5	1.57	0.50
Any ankle and/or lower leg procedure ‡**	1	0.28	22	1.65	2	0.79	4	1.25	0.19
Any lower extremity (non-ankle) injury ‡	7	1.94	29	2.18	6	2.38	6	1.88	0.97
Any knee injury ‡	0	0.00	5	0.38	0	0.00	3	0.94	0.17
Any hip injury ‡	4	1.11	10	0.75	3	1.19	2	0.63	0.73
Any vertebral column injury ‡	2	0.56	11	0.83	4	1.59	4	1.25	0.46
Injury to multiple body parts ‡††	6	1.67	38	2.86	11	4.37	10	3.13	0.27
Musculoskeletal injury ‡‡‡	10	2.78	38	2.86	10	3.97	9	2.82	0.80
Any traumatic (non-ankle) injury ‡‡‡	24	6.67	115	8.65	23	9.13	27	8.46	0.64
Any type of injury ‡§§	34	9.44	158	11.88	33	13.10	39	12.23	0.50
Non-injury hospitalization or outpatient visit ‡§§	57	15.83	183	13.76	40	15.87	48	15.05	0.67
Ankle injury severity :									
1 outpatient visit	1	0.28	31	2.33	9	3.57	11	3.45	
>1 outpatient visit, no hospitalization	4	1.11	10	0.75	1	0.40	3	0.94	
≥1 outpatient visit and/or hospitalization	1	0.28	5	0.38	1	0.40	1	0.31	0.27

* First time attendees starting airborne training 10/1/1998 -12/1/2006.

† Last recorded jump week training dates corresponding to PAB Protocol were as follows: Brace I 10/1/1998 to 9/30/2000, No brace I 10/1/2000 to 7/4/2005, Brace II (Co A & B) 7/5/2005 to 12/11/2006, No brace II (Co C & D) 7/5/2005 to 12/11/2006.

‡ Hospitalization or outpatient appointment occurring during a 14 day period from the start of latest jump week through the week following airborne training.

§ Ankle fracture outcome is subset of ankle injury outcome.

** Any ankle procedure is based on CPT codes (not ICD-9 codes) and overlaps with ankle injury.

†† Injury to multiple body parts overlaps with all other outcomes.

‡‡ Musculoskeletal injury and any traumatic non-ankle injury outcomes include ICD codes also found in knee, hip, vetebral column, and lower extremity injuries, but not ankle.

Any traumatic (non-ankle) injury includes both musculoskeletal (non-ankle) injury and soft-tissue injuries.

§§ A trainee could have both injury and non-injury hospitalization and/or outpatient visit(s).

DISCUSSION

This evaluation of injury among women was limited by the relatively small number of women attending Airborne School, as well as the small number of injury events. Nonetheless, descriptive results were fairly similar to those for men: there were more frequent Turnbacks, older students, and longer duration of service among those trained most recently (Brace II and No Brace II). Unlike the men, who appeared to have slightly higher graduation rates during brace use periods, graduation rates for women did not show any apparent pattern in association with PAB use.

Overall, ankle injury occurred more frequently among women than men (3.4% vs. 1.5%, respectively), but use of the PAB was not associated with risk of ankle injury among women trainees.

OVERALL CONCLUSIONS

The vast majority, 78%, of students who started Airborne School completed the program in the scheduled three weeks, and most of those who started the program, 86%, completed it successfully. Even students who were turned back during training, i.e., experienced interruptions, were likely to return to the program and successfully complete it, demonstrating appropriate selection into Airborne School and adequate rehabilitation or remedial training for those who needed it.

Injury during the year prior to entry into the Airborne School was more common among students whose training was delayed or who did not complete Airborne School than those who completed the program. Prior injury history may thus prove a useful indicator to identify students in need of different training or more careful surveillance during Airborne School to assure success in the program.

This study corroborates previous investigations that identified reduced risk of ankle injury among men when the PAB was used during Airborne training (7, 10) with no accompanying increase in the risk of other injuries (2, 7, 11), including VCI. The findings reported here were consistent when analyses were focused on men who entered training, men who finished training, and when training was defined on the basis of first or last recorded jump week. It was not possible to carry out as complete an analysis for women, due to the small numbers of women who entered the Airborne School during the study period. Descriptive analyses at least demonstrated no increases in injuries associated with use of the PAB by women, but the apparent lack of association between injury risk and PAB use in women trainees bears further examination.

RECOMMENDATIONS

1. All men entering Airborne School as students should use the PAB during training.

The consistency among results of all investigations as to the effectiveness of the PAB for men undergoing Airborne training clearly indicates that the PAB can reduce individual morbidity and financial costs to the Army. The PAB is cost-effective, with estimated savings of $7 to $9 in medical and personnel costs for every dollar spent on the PAB (8).

2. Consider more wide-spread use of the PAB by men in non-training activities, including combat scenarios.

Few studies have evaluated use of the ankle brace in actual combat conditions. If our finding of reduced risk of ankle injury associated with using the PAB during training holds true in non-training settings, there is likely to be a benefit on military readiness, in addition to the immediate and obvious direct effects on the well-being of individual Soldiers and medical costs associated with treating injuries.

3. Further evaluate the effectiveness of the PAB used by women undergoing training at the Airborne School.

The apparent lack of association between the PAB and injury risk among women trainees should be followed up with more detailed data collected to elucidate events preceding injuries and the mechanisms of injuries, both of which may differ for men and women. It is possible that the equipment needs of women parachutists are different than those of men, suggesting modifications to the boot, the PAB, the parachute or all three may be warranted.

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APPENDIX A: CATEGORIZATION OF INJURY DIAGNOSIS AND PROCEDURE CODES

Outcome	SAS variable name	Inpatient ICD-9-CM codes	Outpatient ICD-9-CM CPT codes
Ankle injury	ANK_INJ	824 , 837, 8450 , 84500 , 84501 , 84502 , 84503 , 84509	Same as inpatient ICD-9-CM codes, plus: 92421,92821,71617,71807,71817,71827,71837, 71847, 71857, 71867,71877, 71887, 71897, 71907, 71917, 71927, 71937, 71947, 71957, 71967, 71977, 71987, 71997, 72706, 7267
Ankle fracture	ANK_FX	824	
Ankle procedure	ANK_PROC	7906,7907,7916,7917,7926,7927,7936,7937,7977,7987,7939,8017,8027,8087, 8149	CPT codes: 27600 27745 27830 27831 27832 27870:27899, 27756, 27758, 27759, 27766, 27784, 27792, 27814, 27822, 27823, 27826, 27827, 27828, 27829, 27846, 27848, 27860,,27750, 27752, 27760, 27762, 27780, 27781, 27786, 27788, 27808, 27810, 27816, 27818,27824,27825,27840,27842,29305-29590
Musculoskeletal injury	MSKL_INJ	808, 820, 821, 822, 823, 825, 826, 827, 828, 835, 836, 838, 843, 844, 846, 8054, 8055, 8056, 8057, 8058, 8059, 8064, 8065, 8066, 8067, 8068, 8069, 8451, 8472, 8473, 8474, 8485, 83920, 83930, 83941, 83942, 83951, 83952, 83969, 83979	Same as inpatient ICD-9-CM codes

Outcome	SAS variable name	Inpatient ICD-9-CM codes	Outpatient ICD-9-CM CPT codes
Traumatic brain injury	TBI_37	8001-8004, 8006-8009, 80003- 80005, 80053 80055, 8011-8014, 8016-8019, 80103-80105, 80153-80155, 8031-8034, 8036-8039, 80303-80305, 80353-80355, 8041-8044, 8046-8049, 80403-80405, 80453-80455, 8502-8504, 851-854, 9501-9503, 99555, 80000, 80002, 80006, 80009, 80100, 80102, 80106, 80109, 80300,,80302, 80306, 80309, 80400, 80402, 80406, 80409, 80050, 80052, 80056, 80059, 80150, 80152, 80156, 80159, 80350, 80352, 80356, 80359, 80450, 80452, 80456, 80459, 8500, 8501, 8505, 8509, 80001, 80051, 80101, 80151, 80301, 80351, 80401, 80451	Same as inpatient ICD-9-CM codes, plus: 9070, 9071, 950, 951
Other head (non-TBI) and neck injury	OTHHN_38	951,8730,8731,8738,8739, 95901, 802, 830, 8480, 8481, 872, 8732-8737, 9500, 9509, 870-871, 921, 918, 940, 8075-8076, 8482, 9252, 9530, 9540, 874, 9251, 900, 9570, 910, 920, 9470, 95909,94100-94109	Same as inpatient ICD-9-CM codes, plus: 9050, 9060, 9065, 9083, 9590, 925, 941
Spinal cord injury	SCI_40	8060-8061, 9520, 8062-8063, 9521, 8064-8065, 9522, 8066-8067, 9523-9524, 8068-8069, 9528-9529	Same as inpatient ICD-9-CM codes, plus: 9072, 9051, 9073, 953, 952
Vertebral column injury	VCI_41	8050-8051, 8390-8391,8470, 8052-8053, 83921, 83931,8471,8054-8055, 83920, 83930,8472, 8056-8057, 83941, 83942, 83951-83952, 8473-8474, 8058-8059, 83940, 83949, 83950, 83959	Same as inpatient ICD-9-CM codes, plus: 7220, 7231, 7233, 7234, 7239, 73313

Outcome	SAS variable name	Inpatient ICD-9-CM codes	Outpatient ICD-9-CM CPT codes
Chest injury	CHEST_19	8070-8074, 83961, 83971, 8483-8484, 92619, 860-862, 901, 9531, 875, 8790, 8791, 9220, 9221, 92233, 94201, 94202	Same as inpatient ICD-9-CM codes, plus: 9080, 9084, 901
Abdomen injury	ABD_20	863-866, 868, 9020-9024, 9532, 9535, 8792-8795, 9222, 94203, 9473	Same as inpatient ICD-9-CM codes, plus:9029, 9081, 911
Pelvis injury	PELV_21	808, 83969, 83979, 846, 8485,9260, 92612, 867, 9025, 90281- 90282, 9533, 877-878, 9224, 94205, 9474	Same as inpatient ICD-9-CM codes, plus: 9024, 9028, 71615, 71805, 71815, 71825, 71835, 71845, 71855, 71865, 71875, 71885, 71895, 71905, 71915, 71925, 71935, 71945, 71955, 71965, 71975, 71985, 71995
Trunk injury	TRUNK_22	809, 9268-9269, 9541, 9548-9549, 8796-8797, 9228-9229, 911, 94200, 94210, 94220, 94230, 94240, 94250, 94209, 94219, 94229, 94239, 94249, 94259, 9591	Same as inpatient ICD-9-CM codes, plus: 9081, 9260, 92612, 9268, 942, 954
Back injury	BACK_23	8479, 92611, 876, 92232, 92231, 94204, 94214, 94234, 94244, 94254	Same as inpatient ICD-9-CM codes, plus: 724, 9223, 92611
Shoulder injury	SHLDR_24	810-812, 831, 840, 880, 8872-8873, 94303-94306, 94313-94316, 94323-94326, 94333-94336, 94343-94346, 94353-94356, 912, 9230, 9270, 9592	Same as inpatient ICD-9-CM codes, plus: 955, 7260, 7261, 9074, 7262, 92300, 92301, 92302, 92700, 92701, 92702, 71611, 71801, 71811, 71821, 71831, 71841, 71851, 71861, 71871, 71881, 71891, 71901, 71911, 71921, 71931, 71941, 71951, 71961, 71971, 71881, 71891
Forearm injury	FARM_25	813, 832, 841, 88100, 88110, 88120, 88101, 88111, 88121, 8870-8871, 9231, 9271, 94301, 94302, 94311, 94312, 94321, 94322, 94331, 94332, 94341, 94342, 94351, 94352	Same as inpatient ICD-9-CM codes, plus: 913, 9593, 92310, 92710, 92711, '71613, '71803, '71813, '71823, '71833, 71843, 71853, 71863, 71873, '71883, 71893, 71903, 71913, 71923, 71933, 71943, 71953, 71963, 71973, 71983, 71993, 72704

Outcome	SAS variable name	Inpatient ICD-9-CM codes	Outpatient ICD-9-CM CPT codes
Wrist injury	WRST_26	814-817, 833-834, 842, 88102, 88112, 88122, 882-883, 885-886, 914-915, 9232-9233, 9272-9273, 944, 9594-9595	Same as inpatient ICD-9-CM codes, plus: 9066, 9273, 7264, 92321, 92721, 71614, 71804, 71814, 71824, 71834, 71844, 71854, 71864, 71874, 71884, 71894, 71904, 71914, 71924, 71934, 71944, 71954, 71964, 71974, 71984, 71994, 72705
Other upper extremity injury	OTHUE_27	818, 884, 8874-8877, 903, 913, 9593, 9238-9239, 9278-9279, 9534, 955, 94300, 94310, 94320, 94330, 94340, 94350, 94309, 94319, 94329, 94339, 94349, 94359	Same as inpatient ICD-9-CM codes, plus:912, 914, 915, 943, 9052, 7263, 92303, 92309, 92311, 92320, 92720, 92703, 71612, 71802, 71812, 71822, 71832, 71842, 71852, 71862, 71872, 71882, 71892, 71902, 71912, 71922, 71932, 71942, 71952, 71962, 71972, 71982, 71992
Hip injury	HIP_28	820, 835, 843,92401, 92801	Same as inpatient ICD-9-CM codes, plus: 7265, 9596
Upper leg injury	UPLEG_29	821, 8972-8973, 92400, 92800, 94506, 94516, 94526, 94536, 94546, 94556	Same as inpatient ICD-9-CM codes, plus:9053, 73314, 73315
Knee injury	KNEE_30	822, 836, 8440-8443, 92411, 92811, 94505, 94515, 94525, 94535, 94545, 94555	Same as inpatient ICD-9-CM codes, plus: 717, 7266
Lower leg injury	LOLEG_31	823-824, 8970-8971, 837, 8450, 92410, 92421, 92810, 92821, 94503, 94513, 94523, 94533, 94543, 94553, 94504, 94514, 94524, 94534, 94544, 94554	Same as inpatient ICD-9-CM codes, plus: 9597, 71616, 71806, 71816, 71826, 71836, 71846, 71856, 71866, 71876, 71886, 71896, 71906, 71916, 71926, 71936, 71946, 71956, 71966, 71976, 71986, 71996, 73316, 72671, 73393
Foot injury	FOOT_32	825-826, 838, 8451, 892-893, 895-896, 917, 92420, 9243, 92820, 9283, 94501, 94511, 94521, 94531, 94541, 94551, 94502, 94512, 94522, 94532, 94542, 94552	Same as inpatient ICD-9-CM codes, plus: 72871, 73394

Outcome	SAS variable name	Inpatient ICD-9-CM codes	Outpatient ICD-9-CM CPT codes
Other lower extremity injury	OTHLE_33	827, 8448-8449, 890-891, 894, 8974-8977, 9040-9048, 916, 9244-9245, 9288, 9289, 9596-9597, 94500, 94510, 94520, 94530, 94540, 94550, 94509, 94519, 94529, 94539, 94549, 94559	Same as inpatient ICD-9-CM codes, plus: 904, 945, 956, 9054, 9075, 9243, 9248, 9249, 71617, 71807, 71817, 71827, 71837, 71847, 71857, 71867, 71877, 71887, 71897, 71907, 71917, 71927, 71937, 71947, 71957, 71967, 71977, 71987, 71997, 72706, 7267
Other/ multiple sites	MULT_34	829, 8398-8399, 8488-8489, 869, 8798-8799, 9029, 9049, 919, 9248-9249, 929, 946, 9478-9479, 948-949, 9539, 9571, 9578-9579, 9598-9599	Same as inpatient ICD-9-CM codes, plus: 9055, 9288, 9278, 92709, 71619, 71809, 71819, 71829, 71839, 71849, 71859, 71869, 71879, 71889, 71899, 71909, 71919, 71929, 71939, 71949, 71959, 71969, 71979, 71989, 71999

APPENDIX B: Final Model, Ankle Injury

Male Cohort: Multivariable Model, All Covariates Associated with Ankle Injury[a] (p<=0.05) Among U.S. Army Airborne School Male Trainees,[b] 1998-2006 (n=68,418)

	Final Model		
	Rate ratio	95% CI	p-value
PAB protocol			
Brace I	0.60	0.47 - 0.75	<0.0001
No Brace I	1.00		--
Brace II	0.62	0.49 - 0.78	<0.0001
No Brace II	0.94	0.78 - 1.14	0.55
Age at start of training (yrs)			
17-18	1.00		--
19	1.26	1.00 - 1.60	0.05
20-21	1.55	1.24 - 1.94	0.0001
22-23	1.74	1.37 - 2.20	<0.0001
24-44	2.23	1.79 - 2.79	<0.0001
Rank			
Enlisted (E1-E9)	1.00		--
Officer/Warrant Officer	1.51	1.23 - 1.84	<0.0001
Duration of service			
0 to 16 wks	1.00		--
17-19 wks	0.96	0.79 - 1.17	0.72
20-24 wks	0.78	0.64 - 0.96	0.02
25-36 wks	0.81	0.66 - 0.98	0.03
37 wks to 8 yrs	1.00	0.83 - 1.21	1.00
Ankle Injury during previous year			
No	1.00		--
Yes	1.63	1.39 - 1.91	<0.0001
Non-Ankle Injury during previous year			
No	1.00		--
Yes	1.22	1.07 - 1.38	0.002
TurnBack			
No	1.00		--
Yes	1.88	1.59 - 2.22	<0.0001

APPENDIX C: Final Model, Non-ankle Injury

Male Cohort: Multivariable Model, All Covariates Associated with Non-ankle Injury[a] (p<=0.05) Among U.S. Army Airborne School Male Trainees,[b] 1998-2006 (n=68,418)

	Final Model		
	Rate ratio	95% CI	p-value
PAB protocol			
Brace I	0.77	0.68 - 0.88	0.0002
No Brace I	1.00		--
Brace II	0.92	0.81 - 1.05	0.23
No Brace II	0.86	0.75 - 0.97	0.02
Age at start of training (yrs)			
17-18	1.00		--
19	1.12	0.96 - 1.30	0.15
20-21	1.43	1.24 - 1.65	<0.0001
22-23	1.65	1.42 - 1.91	<0.0001
24-44	2.23	1.94 - 2.56	<0.0001
Rank			
Enlisted (E1-E9)	1.00		--
Officer/Warrant Officer	1.31	1.14 - 1.50	0.0001
Duration of service			
0 to 16 wks	1.00		--
17-19 wks	0.92	0.81 - 1.04	0.18
20-24 wks	0.78	0.69 - 0.89	0.0002
25-36 wks	0.79	0.70 - 0.90	0.0004
37 wks to 8 yrs	0.88	0.78 - 1.00	0.04
Ankle Injury during previous year			
No	1.00		--
Yes	1.30	1.17 - 1.45	<0.0001
Non-Ankle Injury during previous year			
No	1.00		--
Yes	1.56	1.44 - 1.69	<0.0001
TurnBack			
No	1.00		--
Yes	1.87	1.69 -2.08	<0.0001

APPENDIX D: Final Model, Vertebral Column Injury

Male Cohort: Multivariable Model, All Covariates Associated with Vertebral Column Injury[a] (p<=0.05) Among U.S. Army Airborne School Male Trainees,[b] 1998-2006 (n=68,418)

	Final model		
	Rate ratio	95% CI	p-value
PAB protocol			
Brace I	0.42	0.19-0.90	0.03
No Brace I	1.00		--
Brace II	0.95	0.55-1.65	0.86
No Brace II	1.08	0.65-1.79	0.77
Age at start of training (yrs)			
17-18	1.00		--
19	1.40	0.70-2.80	0.34
20-21	1.83	0.95-3.52	0.07
22-23	1.96	0.98-3.88	0.06
24-44	3.18	1.71-5.90	0.0003
Non-Ankle Injury during previous year			
No	1.00		--
Yes	1.43	1.01-2.03	0.04
TurnBack			
No	1.00		--
Yes	1.75	1.09-2.80	0.02

APPENDIX E: Final Model, Musculoskeletal Injury

Male Cohort: Multivariable Model, All Covariates Associated with Musculoskeletal Injury[a] (p<=0.05) Among U.S. Army Airborne School Male Trainees,[b] 1998-2006 (n=68,418)

	Final model		
	Rate ratio	95% CI	p-value
PAB protocol			
Brace I	0.68	0.54-0.87	0.002
No Brace I	1.00		--
Brace II	0.81	0.64-1.03	0.09
No Brace II	0.79	0.63-1.00	0.05
Age at start of training			
17-18	1.00		--
19	1.09	0.83-1.43	0.52
20-21	1.60	1.25-2.05	0.0002
22-23	2.00	1.55-2.58	<0.0001
24-44	2.54	2.00-3.22	<0.0001
Ankle Injury during previous year			
No	1.00		--
Yes	1.26	1.04-1.53	0.02
Non-Ankle Injury during previous year			
No	1.00		--
Yes	1.33	1.16-1.54	<0.0001
TurnBack			
No	1.00		--
Yes	1.70	1.41-2.06	<0.0001

APPENDIX F: Final Model, Lower Extremity Injury

Male Cohort: Multivariable Model, All Covariates Associated with Lower Extremity Injury[a] (p<=0.05) Among U.S. Army Airborne School Male Trainees,[b] 1998-2006 (n=68,418)

	Final Model		
	Rate ratio	95% CI	p-value
PAB protocol			
Brace I	0.68	0.52-0.88	0.004
No Brace I	1.00		--
Brace II	0.93	0.74-1.19	0.60
No Brace II	0.79	0.62-1.02	0.08
Age at start of training (yrs)			
17-18	1.00		--
19	1.01	0.77-1.32	0.95
20-21	1.41	1.09-1.81	0.008
22-23	1.57	1.20-2.06	0.001
24-44	2.09	1.63-2.69	<0.0001
Race/ethnicity			
White	1.00		--
Black	0.88	0.67-1.16	0.36
Hispanic	0.85	0.66-1.09	0.20
Other	0.57	0.37-0.88	0.01
Duration of service			
0 to 16 wks	1.00		--
17-19 wks	0.89	0.71-1.12	0.32
20-24 wks	0.85	0.68-1.07	0.17
25-36 wks	0.70	0.55-0.89	0.004
37 wks to 8 yrs	0.76	0.60-0.96	0.02
Non-Ankle Injury during previous year			
No	1.00		--
Yes	1.65	1.42-1.92	<0.0001
TurnBack			
No	1.00		--
Yes	1.99	1.64-2.41	<0.0001

APPENDIX G: Final Model, Knee Injury

Male Cohort: Multivariable Model, All Covariates Associated with Knee Injury[a] (p<=0.05) Among U.S. Army Airborne School Male Trainees,[b] 1998-2006 (n=68,418)

	Final Model		
	Rate ratio	95% CI	p-value
PAB protocol			
Brace I	0.35	0.17-0.71	0.004
No Brace I	1.00		--
Brace II	0.59	0.33-1.07	0.08
No Brace II	0.65	0.37-1.13	0.13
Age at start of training (yrs)			
17-18	1.00		--
19	0.79	0.44-1.42	0.43
20-21	1.32	0.78-2.22	0.30
22-23	2.03	1.21-3.39	0.007
24-44	1.26	0.73-2.16	0.41
Non-Ankle Injury during previous year			
No	1.00		--
Yes	1.87	1.36-2.58	0.0001
Turn Back status			
No	1.00		--
Turned Back	2.23	1.49-3.33	<0.0001